Polytechnic Institute of Setubal

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Lean IT

Application of 5S/6S Technique in a SME

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"Posso ter defeitos, viver ansioso e ficar irritado algumas vezes,

mas não esqueço de que a minha vida é a maior empresa do mundo.

E que posso evitar que ela vá à falência.

Ser feliz é reconhecer que vale a pena viver apesar de todos os desafios,

incompreensões e períodos de crise.

Ser feliz é deixar de ser vítima dos problemas

e se tornar um autor da própria história.

É atravessar desertos fora de si, mas ser capaz de encontrar

um oásis no recôndito da tua alma.

É agradecer a Deus a cada manhã pelo milagre da vida.

Ser feliz é não ter medo dos próprios sentimentos.

É saber falar de si mesmo.

É ter coragem para ouvir um 'não'.

É ter segurança para receber uma crítica, mesmo que injusta.

Pedras no caminho?

Guardo todas, um dia vou construir um castelo…"

(Fernando Pessoa)

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This dissertation is dedicated to my parents: “Mamy” and “Papy” for all their love, support and kindness. The path was not easy at all but it was meaningful.

The struggle finally ended with a new personal conquest and for hereafter my goal is to continue to give it my best and never let barriers stop me from reaching new horizons.

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List of Acronyms and Abbreviations

BI – Business Intelligence

BPM – Business Process Management

CIO – Chief Information Officer

CRM – Customer Relationship Management

DVD – Digital Versatile Disk

ESCE – *Escola Superior de Ciências Empresariais*

IRIS – Information & Research Instruction Suite

ISO/IEC – International Standard Organization/International Electrotechnical Commission

IT – Information Technology

ITIL – Information Technology Infrastructure Library

JIT – Just In Time

KPIs – Key Performance Indicators

OIS – Organizational Information Systems

PDCA – Plan-Do-Check-Act

PME – Pequena, Média Empresa

ROI – Return of Investment

SME – Small, Medium Enterprises

TI – Tecnologias de Informação

TPS – Toyota Production System

VSM – Value Stream Mapping

WFM – Workflow Management

Abstract

Lean is not just a practice. It is a revolution on Information Technology (IT) with management providing a higher and better optimization of resources and "chasing" lower costs than what exist today.

It is a lot more than series of tools and methodologies and to be implemented we need to change cultural behaviors and encourage all the organizations to think differently about the power of information instead of value in the business.

Usually, we associate Lean to create value for the organization. But value is meaningful when it is brought with efficiency and resulting in eliminating processes that cost unnecessary time, resources and space.

Lean principles can help organizations on quality improvement, cost reduction and achieving efficiency through better productivity.

There are many Lean concepts that can be associated to different goals for problem solving. In particular, this paper is a dissertation programmed to discuss a new paradigm about Lean that emerged recently – Lean for Information Technology (Lean IT).

This dissertation presents an approach to Lean IT (framework, objectives, and methodology) to conduct the paper and use one single Case study with 5S/6S technique evaluation (up to level three) on an IT Small, Medium Enterprises (SME) to demonstrate value added and the advantages of eliminating wasted processes. Technique also shows the evolution before and after its deployment.

This particular single Case study evaluates an IT Department (with a team of five employees and one Chief Department) through systematic observation, documentation and archived records. Equipment represented through computers, workstations and projects (developed code, portals and other IT services).

As a guideline the methodology includes work preparation with IT Department responsible, follow operations, identify value stream for each activity, develop the communication plan and analyse each step of the process flow evaluation.

Main results are reflected on new work tools (Microsoft SharePoint and Microsoft Project instead of Microsoft Excel) that provide remote communication and projects'

control to all project stakeholders such as top management, 3rd party IT team (some organization integrated with 3rd party IT to get particular development) and customers. Results are also reflected on: work quality, deadline, logical and physical security, employees' motivation and customer' satisfaction.

5S/6S technique helps to clarify Lean concepts and principles, practicability and enhance the curiosity about this thematic implementation in other environments such as Finance and Human Resources Departments.

As a way of work consolidation it became possible to organize an assessment in order to apply for an International Standard Organization/International Electrotechnical Commission (ISO/IEC) 25010:2011 certification in software quality model (software is the core business from this SME). But it will only be possible if the entire organization achieve standardization on its processes.

This Case study shows that Lean concepts and the application of one or more of its technique (in this particular case, 5S/6S technique) helps to achieve better results through its core services management and improvement.

Key-words:

Lean | Information Technology | 5S/6S Technique | IT Department

Resumo

O *Lean* não é apenas uma prática. É uma revolução nas Tecnologias de Informação (TI) proporcionando uma maior e melhor utilização dos recursos e procurando alcançar custos mais baixos dos que existem atualmente.

É muito mais do que uma lista de ferramentas e metodologias e para que seja estabelecido é necessário mudar comportamentos culturais e incentivar todas as organizações a pensarem de forma diferente sobre o poder da informação *versus* o valor do negócio.

Normalmente associa-se o *Lean* à criação de valor para a organização. Mas o valor é significativo quando é trazido com eficiência e resultando na eliminação de processos que consomem tempo, recursos e espaço desnecessário.

Os princípios *Lean* podem ajudar as organizações na melhoria da qualidade, redução de custos e no alcance da eficiência através de uma melhor produtividade.

Existem vários conceitos *Lean* que podem ser associados a diferentes objetivos de resolução de problemas. Em particular, este trabalho é uma dissertação programada para analisar um novo paradigma sobre o *Lean* que surgiu recentemente - *Lean* para Tecnologias de Informação (*Lean* IT).

Esta dissertação apresenta uma abordagem para o *Lean* IT (enquadramento, objetivos e metodologia) para realizar o trabalho e utiliza um único estudo de caso, com abordagem à técnica 5S/6S (até o terceiro nível de avaliação), numa Pequena, Média Empresa (PME), de forma a demonstrar a agregação de valor e as vantagens na eliminação de resíduos/desperdícios nos seus processos. A técnica também mostra a evolução da avaliação antes e depois da sua aplicação.

Este estudo de caso individual avalia um Departamento de TI (com uma equipe de cinco colaboradores e um chefe de Departamento) através da observação direta, documentação e arquivos de registos e os equipamentos analisados são computadores, postos de trabalho e projetos (código desenvolvido, portais e outros serviços de TI).

Como guia, a metodologia inclui a preparação da avaliação em conjunto com o responsável/chefe do Departamento de TI, o desenrolar das operações, a identificação do fluxo de valor para cada atividade, o desenvolvimento de um plano de comunicação e a análise de cada passo da avaliação do fluxo de processamento.

Os principais resultados estão refletidos nas novas ferramentas de trabalho (*Microsoft SharePoint* e *Microsoft Project* em detrimento do *Microsoft Excel*) que fornecem comunicação remota e controlo de projetos para todos os *stakeholders*, tais como, a gestão de topo, parceiros e clientes (algumas organizações incluem o *Outsourcing* no desenvolvimento de funcionalidades específicas). Os resultados também refletem-se na qualidade do trabalho, no cumprimento de prazos, na segurança física e lógica, na motivação dos colaboradores e na satisfação dos clientes.

A técnica 5S/6S ajuda a esclarecer os conceitos e princípios *Lean*, exequibilidade e aumenta a curiosidade sobre a implementação da técnica noutros departamentos tais como o Financeiro e ou o de Recursos Humanos.

Como forma de consolidação do trabalho tornou-se possível organizar a avaliação para que a organização possa candidatar-se a uma certificação na norma ISO/IEC 25010:2011, no modelo de qualidade de software (software é o *core business* desta PME). Mas tal só será possível se toda a organização atingir a padronização dos seus processos.

Este estudo de caso mostra que os conceitos *Lean* e a aplicação de uma ou mais das suas técnicas (neste caso particular a técnica 5S/6S) ajuda a obter melhores resultados através da gestão e melhoria dos seus principais serviços.

Palavras-chave:

Lean | Tecnologias de Informação | Técnica 5S/6S | Departamento de TI

1. Introduction

There has been a dramatic rise on Information Technology (IT) environment since World Wide communication through Internet became one of the most powerful ways of business trade.

It is important to understand the differences between standard commercial organizations (that are constantly being developed since centuries ago) and new forms of organizations that are highly performed with technology and global communication.

But in order to increase an organizations' performance and capability to deal with this new business environment we must realize how IT can influence the internal resources, how process works and how to manage and establish communication with the external stakeholders.

According to Sanli (2010), an actual IT organization has many supporting roles regarding to helpdesk, operations, software development, project management, hardware (data center services, computers, and machines), network and control.

Monitoring the development through new paradigms seems to be another way of improvement. So, this chapter performs an introduction to Lean concepts across previous research about IT and several thematic such as: IT evolution and nowadays perspective, IT Departments and operations, Software for data security, Lean Thinking and strategies, IT services, Hardware, Lean techniques, and so on.

1.1. Framework

Accomplish the transmission of a new paradigm has always been a challenge. Therefore it is essential to understand its concepts, principles and techniques in order to draw the line of knowledge and possible implementation of learned methods.

With the Information Systems integration, Poppendieck et. al (2006) talks about IT and Organizational purposes. Lean philosophy brought to IT, new perspectives about organization management regarding to processes flow and the elimination of existing waste (Bell (2006b)).

For such development it is necessary to demonstrate that most of Lean concepts emerged from production activities to IT models and are still viable in this new context.

With this in mind (think about Lean IT models) some steps should be stated:

- Identify value and waste in the IT environment;
- Apply one specific technique (in this case, 5S/6S Technique);
- Enable continuous process flow during the application;
- Manage the workplace organization and office structure;
- Identify, map and analyse value streams;
- Monitor Lean metrics for IT performance;
- Reflect results in visual management;
- Discuss changes within the IT environment.

Applying Lean principles should be related to eliminate process waste, sustain knowledge, plan future changes, deliver as fast as possible and, with the required features, to empower the operational team with build quality associated and optimize the whole process flow and related resources related.

Ultimately the biggest challenge is to decrease cost while successfully implementing the technique according to the needs of the business: promoting efficiency and better service to customers and improving productivity (ComputerWorld (2008)).

Finally, the technique should reflect benefits and areas of possible implementation.

So, this paperwork investigation and development consists in clarifying all the descriptions above, trying to get answers for business sustainability.

According to Yin (2002) one single Case study should reveal details about relevant procedures in SME environment that could be replicated in other circumstances, although it does not mean that all the references should be the same as some features are intrinsic in each organization.

This might make a contribution to understand the Lean paradigm associated to IT and launch new perspectives of work definition: clean, fast, with value added and residual or no waste.

1.2. Proposition

The purpose of this dissertation is to understand how the Lean IT concept and one of its technique (5S/6S) could improve or add value to an organization.

It is known that Lean applied to technology is a new approach and it is still a huge challenge to clarify if it is a good and proper step to follow.

The final research question is: *"How could 5S/6S add value to an organization?"*, starting in a SME.

It was a sort of junction of different concepts connected to Lean and Information Technology.

As inspiration were the questions formulated at the book "Lean IT: Enabling and Sustaining Your Lean Transformation" wrote by Steve Bell and Mike Orzen (2010). Such questions were:

- Is business process improvement part of Lean IT?
- What about best practices and benchmarking?
- Is agile software development a Lean IT practice?
- What about IT operational excellence?
- Is applying Lean techniques to project management considered a Lean IT practice?

They formulated one 'simple' answer to those questions: yes. But there are still other questions to be made and experimented.

A literature review involving the process of concepts' transmission (Lean Principles, IT, and so on) was made as well as a presentation of ideas from other authors.

The literature research words were:

- Lean | Lean Thinking | Lean Manufacturing | Lean Toolbox;
- Technology | IT | Software;
- Value | Lean IT | Lean Techniques | 5S/6S Technique.

Also, to add value to this paper, it is proposed to experiment and analyse the 5S/6S Technique according to a single case study planned to a SME.

Case study is a simulation technique that allows us to observe practical knowledge.

After collecting and evaluating the facts, one or various problems must be defined and alternate solutions should be generated. According to observation and analysis, determined by the organization culture and position, the author must elaborate and present a plan to solve the problem.

When final conclusions about Lean and its practicability are delivered to the administration (with emphasis in IT on the enterprise dynamics) they should demonstrate if the topics where the process flow and value aggregated are or are not essential to the system delivery path.

The Dissertation should respond to the main question, aligning perspectives of future general development in other departments or SMEs.

1.3. Objectives

General objectives are related to topics that should be perceived by everyone. They contribute to understand the main purpose of the investigation. Usually they are associated to the research execution and possible impact on a specific environment.

As an approach, this paperwork started to study some articles, thesis and dissertations about the thematic or similar (Lean regarding to IT is a relative new concept so it is necessary to refer to themes such as Lean Manufacturing, Production or Services as original approaches) and consider the characteristics from a specific SME (each SME represents one particular structure and work methodology).

It is necessary to clarify the main concept (Lean applied to IT) but to accomplish that it is imperative to understand the qualitative and quantitative investigation, different approaches, methodologies and techniques.

Generally, the objective is to demonstrate the applicability of 5S/6S Technique regarding to an IT Department and according to analysis and future results, if possible, extrapolate to other departments and/or global organization, the benefits of Lean implementation in these kinds of environments.

However, just general purposes are difficult to summarize and understand. Specific objectives with minor goals, when globally accomplished go against the general ones and help to reach the main purpose. They are concrete targets for the project scope and correspond to the expected results.

1. This dissertation aims to present Lean concepts, principles and methodologies so that the Information System Community and general public can learn and absorb new terms, definitions and practicability;

2. Study and analyse Lean IT phenomenon and 5S/6S Technique.

3. Last, but not the least, demonstrate the 5S/6S Technique applicability (through a case study) in a SME context (IT Department).

To correctly build specific objectives they should:

- Determine or quantify the desired result;
- Analyse according to specific methodology (it could be a set of various methodologies);
- Identify an effect and its cause.

According to the characteristics above specific objectives to this dissertation are:

1. Identify, describe, measure and eliminate (or reduce) waste incorporated in information system process flow in a SME;

2. Involve, teach and discuss with team or department the advantages, limitations and future work including Lean IT concepts and principles;

3. Increase the amount of necessary value that should be added in a process (use some metrics to establish the comparison before and after the implementation);

4. Implement and test the 5S/6S Technique in a SME;

5. Propose improvements to the administration based on Case study observation and analysis.

If one or more targets are not fulfilled, it should be reported what were the causes and how they could turn into positive or better approaches.

1.4. Motivation

Lean is a paradigm that explores new forms of processes' organization. It is a perception of processes workflow and how we should act to minimize or even try to eliminate waste in our workstations.

Although all the applications of this thematic is mainly in production systems (there are Lean metrics constantly being applied since the practices were established in Toyota Production System (TPS) by Taiichi Ohno and Kiichiro Toyoda, in the 1930s), Lean regarding to IT takes less than ten years (now we can verify the exponential growth of Web communication, applications and usage of IT equipment to communicate).

According to Spanos (2012) *"...the software maintenance definition refers to changes for defect correction, performance improvements, or adaptations to a changed environment (enhancements)."*

There are not enough case studies about Lean IT. Some dissertations talked about Lean supporting IT but did not mention a practical approach to a specific department with a specific technique (Eriksson (2011) explored these thematic doing a qualitative study of municipalities, questioning if they knew about this new paradigm, its benefits and applications and recently Guedes (2011) talked about Lean IT on bank environment).

So, it became motivating to try to understand the applicability of one specific technique that could express the benefits of Lean IT to an organization. If it is possible to prove that it actually helps to improve the workstation flow, somehow it might help in other IT environments or departments.

1.5. Methodology

To define a methodology, Yin (2002) emphasizes that there are likewise, other ways to explore and observe a phenomenon: through experiments, surveys, histories and analysis of archival information. Yin (2002) also established a comparison to choose the right research strategy: experiment, survey archival analysis, history or case study. These strategies are adopted according to:

- Type of research question;
- The control that an investigator has over actual behavioral events;
- Focus on contemporary as opposed to historical phenomena (real-life context).

In the same book, Yin (2002) explains that data provided for case studies can come from different sources of evidence. Some of them are: documentation, archival records, interviews, direct observations, participant-observations and physical artifacts, but a complete list of sources can be quite extensive. Usually, these are the most adopted.

The benefits from these sources of evidence can be maximized if we take in consideration, three principles (Yin (2002)):

1. Use multiple sources of evidence: if possible;
2. Create a Case study database: organizing and documenting the data collected for case studies;
3. Maintain a chain of evidence: to increase the reliability of the information.

Because the main goal of this paper is to answer the research question *"How could 5S/6S add value to an organization?"* ("How": one of the forms of research questions in case studies) and the focus is on contemporary events and not in controlling behavioral events, the formulation of a Case study is the most appropriate research strategy.

To implement the strategy, three sources of evidence support the method:

1. Documentation;
2. Archival records;
3. Direct Observations.

Reporting a Case study means to relate and find results to the research question and understands if such paradigm is valid to be adopted. The report does not follow any particular or stereotypic form. Illustration 1 is the methodological approach adopted to respond to the main question of this dissertation.

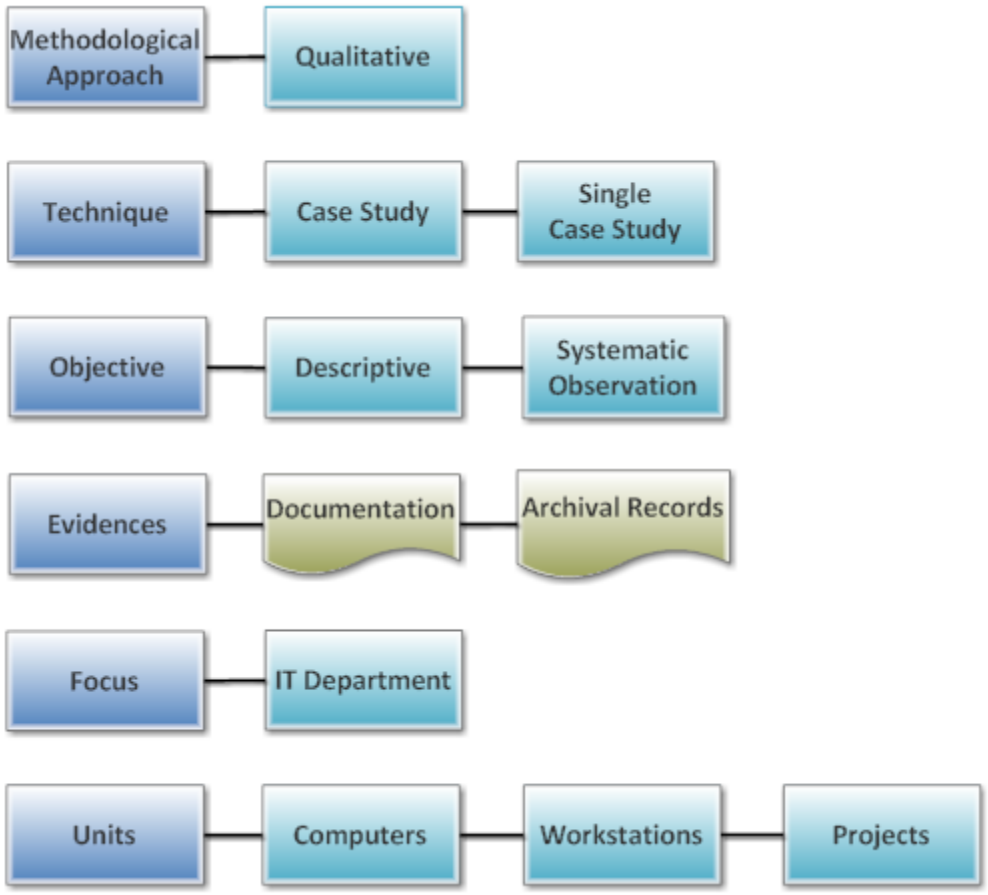

Illustration 1 – Methodological Approach Adopted

Source: Oneself, 2012

Methodology approach to this Case study focuses on SME. This particular SME works on technology environment and its dimension is between 10 to15 employees.

Due to confidentiality issues it is not possible to expose the SME designation so, any reference to the organization through this dissertation will be referred as SME.

5S/6S technique application will be on IT Department with the support of 5 employees and IT Department responsible. Communication between employees, responsible and top management is informal. This type of environment provides easy access to management and proximity to solve problems.

1.6. Dissertation Structure

This Dissertation has six chapters related to the investigation of the Lean IT and the application of 5S/6S Technique into a SME. This Introductory chapter (Chapter 1) focused on the dissertation framework, proposition, main objectives/goals, motivation and methodology approach necessary to answer the main question of the dissertation: *"How could 5S/6S add value to an organization?"*, and is followed by a literature review.

Chapter 2 includes a **literature review** for concepts such as Lean (original standards), Lean IT (evolution to new IT paradigms) and 5S/6S Technique (regarding to Lean IT and a well-organized workplace, with visual controls). The last subject from this chapter will resume all the information about these concepts.

Chapter 3 presents the **methodological research** about differences between qualitative and quantitative research and introduces case study as the qualitative methodology adopted to answer to the main question of this dissertation. Yin (2002), Silva & Menezes (2005), Hopen et. al (1996) and others are valuable references to the study.

Chapter 4 introduces the **case study** that is used as part of the methodology approach to an IT department (in a SME). It also describes organization mission, vision, values and organogram and also, forms of evidence to the case study, human resources involved and the first rule to get ready for the case study.

Chapter 5 refers to **data analysis and discussion** about results. The application it is done with support in documentation, archival records and systematic observation on the IT

department. Forms to 6S evaluation and 5S work area will help to understand the application of 5S/6S technique.

The final chapter, Chapter 6, summarizes **conclusions** about Lean concepts, research methodologies, literature review and case study implemented in an IT department. It will answer the question: *"How could 5S/6S add value to an organization?"*. It indicates the cycle time and project ROI (Return of Investment) as key factors to have good improved results.

A **future work perspective** leads to a whole range of Lean IT concepts and techniques that could be applied on other departments, consolidating the Lean perspective to the entire organization.

2. Literature Review

The dissertation involves the concept of a new paradigm that is emerging in our society: Lean applied to IT. However, the Lean concept as a different background – it appears from a manufacturing concept.

Technology is networked across organizations, stakeholders and World Wide.

Due to the revolution in business performance it is crucial to manage the instances around it.

The literature review is supported in theoretical principles about lean, information, computation and algorithmic processes.

They are also related to computational complexity, communication between organizations' structures, business *versus* IT and decisions made on virtual environment.

IT is important to understand what is the information impact allowed on business processes, what adaptations or improvements should be adopted and how people can interact with those concepts.

The Lean approach has been originally attached to manufacturing processes. So, in 1st instance, it might appear to be a production issue but with the exponential increase of hardware, software and web utilization, enterprises had the necessity to organize their processes, teams, departments and administration according to specific information parameters and to reflect the customers' requirements properly.

For such reasons it was crucial to adopt a philosophy that justified and could implement a row of basic workflows, controlling the processes and, if possible, reduce costs and add value to the service or product requested. That is how Lean IT emerged, combining the Lean principles with the information and technology surround it.

2.1. Lean

According to Womack et. al (1990), the philosophy was inspired on the TPS created by Taiichi Ohno and Kiichiro Toyoda although there are other founding concepts approaches.

"...it occurred to them that a series of simple innovations might make it more possible to provide both continuity in process flow and a wide variety in product offerings". (Lean Enterprise Institute, 2009)

Also, according to Poppendieck & Poppendieck (2006, p.19), *"principles are the underlying truths that do not change in time or space."*

Do more adding value with less waste is the Lean Thinking philosophy (Womack et. al (1996)). The essence is to specify value and simultaneously, eliminate or reduce waste (Curran et. al (2009)). And yes, Lean is a business philosophy, not a technique.

As cited by Aitken (2010, p.2), *"Lean is concerned with delivering more value for the business and its customers by increasing the velocity of throughput and minimizing wasteful practices by balancing process flow."*

The thought process of Lean was thoroughly described in the book "The Machine That Changed the World" published in 1990 and written by James Womack, Daniel Roos and Daniel Jones. They classified five Lean principles:

1. Specify the **value** desired by the customer;
2. Identify the **value stream** for each product;
3. Make the product f**low** continuously;
4. Introduce **pull** between all steps where continuous flow is possible;
5. Manage to reach the **perfection** (number of steps, amount of time and information needed are exactly what was claimed by the customer).

The five-step processes to implement the Lean concept are represented bellow on Illustration 2.

The principles and practices are originated from the Lean Manufacturing concept and they can be incrementally implemented and apply subsequent practices.

The focus of Lean is to eliminate waste on all the processes concerning to an organization. Waste is any activity that does not aggregate value to the product or service. It can be reached in various formats: waiting time, erroneous information, unnecessary complexity, poor data quality, and so on. Wastes in all processes drives to higher costs and longer lead times (Scherrer-Rathje et. al (2009), Medina (2011), Cottyn et. al (2008)).

Illustration 2 – The 5 Lean Principles

Source: Lean Enterprise Institute, 2009, p.1

Known also as the seven wastes (*Muda* is the Japanese word to define waste or anything that does not add value), they were identified by Taiichi Ohno (a pioneer of the TPS) and Shigeo Shingo.

Initially, Shigeo Shingo (from 1948 until 1975) identified seven types of wastes. The forward concepts are explained in Schmidt (2009), Aitken (2010), Haaster et. al (2010) and Venitz (2011):

1. Overproduction: produce more than the necessary or required; the result is the excess of inventory which consumes space and requires extra investment; it takes the focus away of what customer really wants;

2. Over processing or non-add-value processing: over effort to something that does not add value to the process; add extra quality (not required) to the product or service aggregates more resources' time; it is work above and beyond specification;

3. Inventory: excess of material that occupies space and is capital that is not circulating; some materials could become obsolete or in need of new reshape; there is no value added;

4. **Defects:** inspection or repair of material in inventory; when repair is needed it is a waste of time and resources, in something that should be already done correctly; right at the first time is the key to succeed;

5. **Transportation:** movement of people, information or material that does not add value to the product or service; there is a risk of damage and loss of product or service; delay, waiting times and human resources' management are characteristics to be watched;

6. **Waiting:** any idle time created when the flow is waiting for a determined process; resources that wait for a determined cycle to be completed; it could be caused by poor workflow continuity, long lead times, failed delivery dates, and so on;

7. **Motion:** movement of resources; time and effort are wasted when human resources make excess of movement to complete a process.

Underutilized people or no or barely employee involvement should not occur. It is necessary to involve the right human resources according to their best abilities. They are the best resources to identify where waste is being generated in the process flow.

The sources of waste can be found everywhere in the process flow. Anything more than customer request is considered as a waste.

But in reality it is about eliminating waste without operating with fewer resources. Instead, it should re-distribute them through the process flow. And it is not necessary to apply the same level of Lean principles, at the same time, to the entire organization.

2.2. Lean IT

As Lean has been adopted by several areas of knowledge, its tools and principles are applied in manufacturing, logistics, distribution, services, retail, healthcare, construction, maintenance, government and recently to IT (Vedpuriswar (2010), Cottyn et. al (2008)).

IT is very unpredictable and difficult to understand when it is going to fail or how improvements can be made. Its applications require huge investments in software, hardware, infrastructures, storage, facilities and more (Riezebos et. al (2009a)).

First Lean IT approach was on Steve Bell book "Lean Enterprise Systems: Using It for Continuous Improvement" (2006).

Nowadays, IT is not just viewed as an investment. It is part of core business of any organization that wants to communicate with stakeholders or operate and manage its processes. So, it must exist a balance between flexibility, delivery time and cost reduction.

Specific actions should be sustained beyond short timeline regarding that human resources are still the most critical component of the process.

Lean and IT pursue the same objectives but their complementarity remains an open issue. IT usually supports Lean practices and techniques (Riezebos et. al (2009b)).

As Melville (2010, p.1) wrote, *"information systems innovation for environmental sustainability demonstrates the critical role that IS can play in shaping beliefs about the environment, in enabling and transforming sustainable processes and practices in organizations, and in improving environmental and economic performance."*

Information Communication and Technologies drove to fundamental changes on the process of technology management (Zhang (2004), Veraszto et. al (2007)). It is nowadays, essential to understand the adaptability and flexibility of businesses in a virtual transaction World and due to that reason many organizations changed their critical business functions to the Internet/Web technology. Goods and services are attached to treatment, processing and information storage. Functions became intrinsic to businesses' primary activities such as online information, database management, desktop control or delivery information (Nicoletti (2011), Sacks et. al (2010), Daft (2008), Carpenter (2009)).

To increase collaborators' productivity, IT provides software and communications technologies that allow them to interact with other stakeholders (administration, other departments, suppliers, customers and so on) (Gupta (2008)).

According to Lean Enterprise Institute (2009) and emphasized by Lean IT Strategies[1], *"Lean IT empowers enterprise agility, enabling leaders to leverage cutting-edge IT capability to deliver enhanced customer value and achieve lasting competitive advantage."*

Such advantages are associated to projects and services. They must be better, faster and cheaper. It is a possibility to save time and money, reducing costs. It is also an opportunity to quickly align resources with strategy (Curran et. al (2009)).

[1] leanitstrategies.com

When applied effectively and with the right tools and frameworks, Lean IT has benefits for organizations such as described by APMG-International (2012):

- Increased customer satisfaction and productivity;
- Reduction of IT costs;
- Reduction in time to changes and clients specifications;
- Increased ability to manage demand.

APMG-International[2] also reminds us that Lean IT is one of the extensions of Lean Manufacturing / Lean Services concepts and principles directed to IT management. It is the materialization of technology information efforts into aggregated value to business and customers and it allows the management of IT initiatives with strategic value. It could be a natural response to all the changes in economics and technology concentrated in specific areas of the process flow (the objective is to reduce development timeline through waste elimination; maps explore waste over delays on the process flow).

But Lean IT is most of all directed to people, not machines. To achieve the last principle of perfection it is crucial that human resources can raise the level of professionalism, learning how to manage this new paradigm, solve problems, improve as a team and be fully motivated to achieve the result intended (Ambler et. al (2011), Bell (2006a), Carpenter (2009)).

As suggested by McDonald (2010) and shown in the following illustration (Illustration 3) the result is an organization shaped in order to balance different actors that collaborate to enhance productivity (noticing that Agile Solution Engineering is not the only solution; different forms, methodologies and software could be aggregated).

It concentrates all the organization on the essential roles to achieve cost reduction.

The final dimension of the triangle is to achieve sustainability. From this, Chief Information Officer (CIO) can ensure that IT services or products are in according with existing orders.

It continues to have the same purpose: eliminate waste and add value to the work (in these terms, regarding to waste in IT processes). Its implementation should be continuous and a long-term process (Ci&T (2012)).

[2] http://www.apmg-international.com/

Examples of IT waste, according to Guidon (2009) could be: significant amount of support work done outside of service desk process, excessive alerts and warnings, constant interruptions, perform multiple roles at the same time, unnecessary documentation, lack of prioritization guidelines, roles technically overspecialized limiting resource flexibility, and so on.

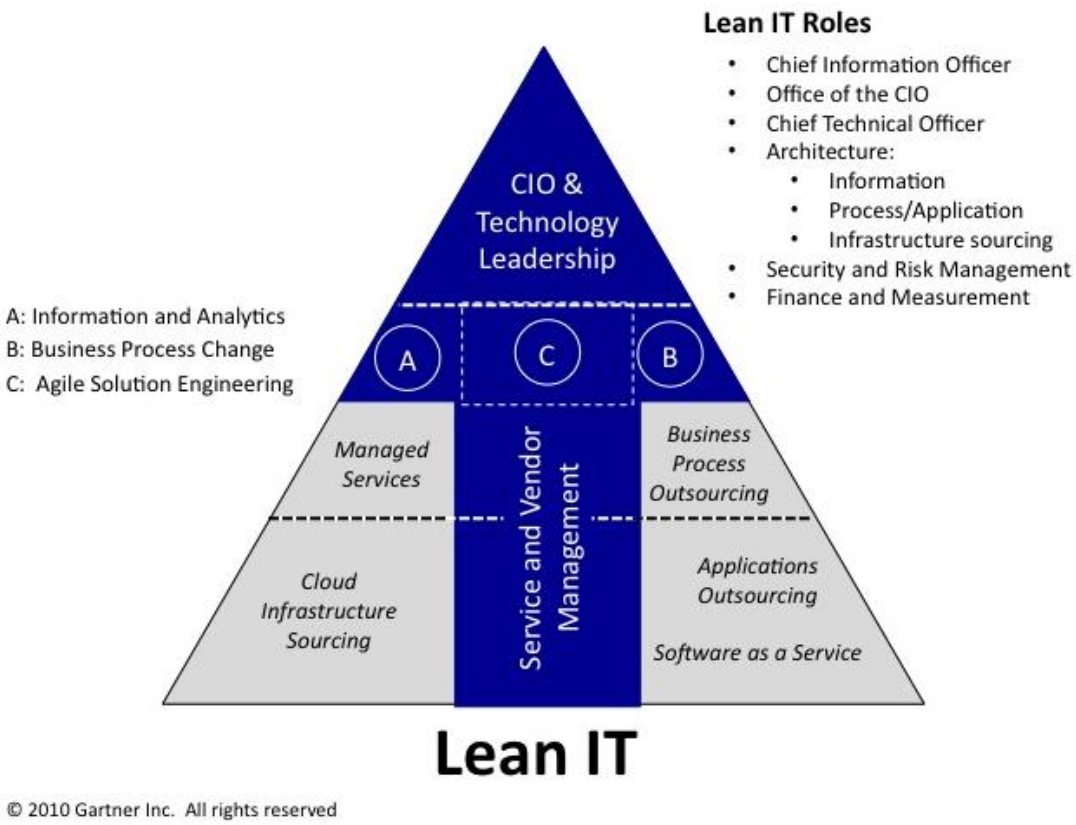

Illustration 3 – Lean IT Roles

Source: Gartner cited by McDonald, M., 2010, p.3

Other classic varieties identified are: rework on past specifications, coders waiting for specifications to be stabilize, testers overproduced, unnecessary overhead for simple tasks, and so on.

System variability is the main source of waste but Information Systems are not just that, it could be tools for business improvement. IT also provides more productivity by

allowing human resources to interact with technologies and increase collaboration on the process flow.

Adapt IT to Lean Principles and methodologies to a digital service oriented flow process it is only beginning. Its services must become more standardized.

Bell (2011a) declared that *"One of the many challenges of an enterprise transformation is the tension between the continuous improvement of business processes and the lack of supporting information systems"*.

Bell (2011a) also emphasizes that is necessary a holistic framework to establish a systematic cultural transformation, aligning business with IT. To organize that framework through IT perspective, it is possible to use Lean principles.

According to Bell & Orzen (2010) fundamental factors that contribute to adjust the perspective are:

- Waste (*Muda*, non-add-value that can or cannot be necessary for the system to function);
- Unnecessary Variation (*Mura*);
- Overburden (*Muri*);
- Local Optimization.

The transformation must be coordinated by a higher level on the organization (administration) and not exclusively attached to individual teams. The transformation effort should improve the service level and relationships between different areas.

Lean IT Principles, according to the five ones established in Loader et. al (2011) are reflected in:

1. Value: aggregated on IT services or products and defined by the customer; IT has changed the view the whole organization has to this specific domain: IT is not anymore just a back office support function it has a center role in delivering customer value.

Indeed, Lean IT initiates with the definition and establishment of balance between value and its cost to the organization and helps the organization to deliver value to its customers.

2. Value Stream: is associated to IT functions, which are used by internal departments, customers, suppliers, human resources and other stakeholders. Services could be for businesses such as supply chain, ecommerce, transaction processing, reporting or IT resources such as backups, performance management, catalogs.

Lean IT Principles principle includes Value Stream Mapping (VSM) technique that is use for analyzing the flow of materials and information which represents all that happens at the organization, from the time of demand to the delivery and the purpose is to build and analyse services' diagrams on their process flow. The required service or product must be delivery with the proper amount of value, as quickly as possible (Bell (2011b), Jones (2011)).

Orzen (2011) presented on the 1st European Lean IT Summit (October 2011)[3] an illustration (Illustration 4) of IT Services value stream:

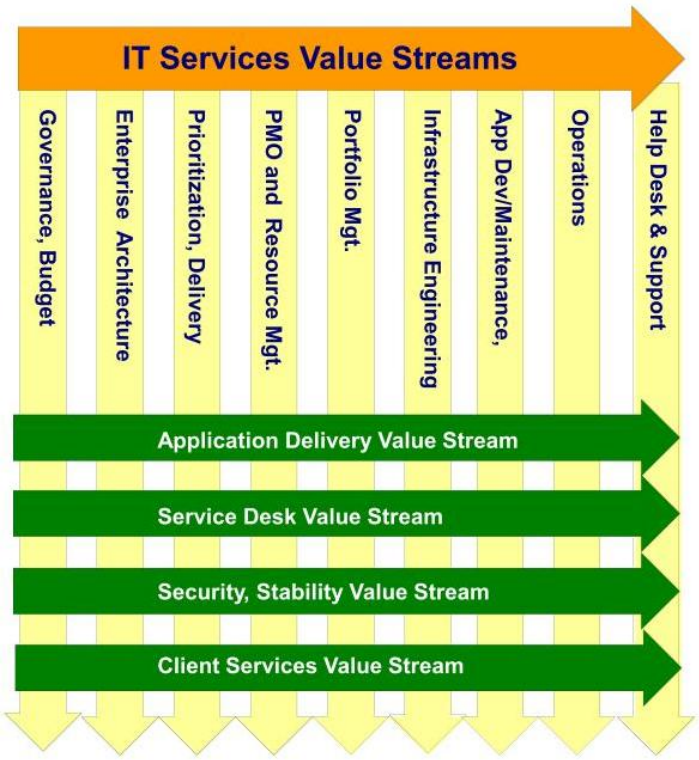

Illustration 4 – IT Value Stream

Source: Orzen, M., 2011, p.7

[3] http://www.lean-it-summit.com/

Lean IT depends on processes that usually are not physical and tangible but digital and intangible. To manage such information, the organizations need tools to visualize and analyse abstract context (McKendrick (2010)). So, it is important to build a VSM to identify opportunities or mistakes to be solved, study the processes' complexity and impact and create ways to measure it.

But first, it is necessary to understand the maturity of the core processes and involve the right resources to each step of the way.

In order to improve the value stream, a Plan-Do-Check-Act (PDCA or so called Deming Cycle) could be adopted to manage the process (Medina (2011), Bell (2012)).

3. Flow: represented through code (familiar internal language) or visual controls is the path through which value stream try to deliver value; it should have a minimum of interruptions or stockpiles;

4. Pull: it is a service/product requested and the value stream through its delivery; Lean IT insists that one step only occurs when a request signal appears; for instance, an online acquisition, database consult, customer information, supply chain management, and so on;

5. Perfection: value, value stream and process flow should be major management concern; improvement must be visible and reachable for the whole organization and all the actors on the value stream must know the quality requirements.

When the target is the software development, Poppendieck & Poppendieck (2006) introduce the following principles, related to the specific encoding field:

1. **Eliminate Waste:** reduce the timeline when waste do not add value to the process flow (since the client request until the delivery and payment);

2. Integrate Quality: build quality code from the beginning of the process; for instance: requirements analysis, system, architecture and module design, system testing, user acceptance and release testing (verification and validation);

3. Build knowledge: a developed process focused on creating knowledge will expect the project to evolve during the encoding before waste time in subdivide prematurely;

4. **Postpone Commitments:** plan irreversible decisions to the last possible moment;

5. **Fast Delivery:** deliver software faster so that customers do not have time to change their minds or customers have their system on time and in line with their business (so they can achieve their finance and customer service goal accordingly).

6. **Respect People:** team must purchase the organization culture and the technical workforce should be specialized. Responsibility is based on planning and control;

7. **Optimize the Hole:** Lean organizations must optimize the value flow, since the request (that should respond to the customer requirement) until software is implemented and customer demand is successfully delivered.

All these principles should develop capacities that aggregate value and are truly relevant to the processes going on. It is also fundamental to understand the information asking questions such as (after exploring the book *"Information Systems"* by Watson (2007)):

- What is the cost add to each step of the process flow?
- How can improvement be measured?
- To always perpetuate the best optimization, how could stakeholders share information?
- How can efficiency be controlled?

Relating these domains with the Organizational Information Systems (OIS) is not difficult. They all search for the best methods, techniques and technologies to sustain an organization.

The focus is on understanding problems that could happen in stakeholders' cycle and apply technologies and information where is needed but with emphasis on the decision level: top management (administration), middle management (departments' chiefs) or bottom management (operational teams) (Naveed (2009)).

Initially, IT components were just related to operations problems (computers failures). Nowadays they have accomplished a bigger role at the whole organization management. They are supporting decisions (financial performance goals, customer service goals, business process goals and optimization) and they now have a leading role as strategic tools to internal and external coordination (Llebrand et. al (2010)).

Besides that, Web as completely revolutionized concepts and notion about what should be available online to customers' knowledge and demands. Management is still the ultimate area to be studied and to those who operated exclusively on the online market it is a question of organization survival.

Also, the supporting equipment attached to the Web concept must be 24 hours / 7 days available and it should allow interoperability (reuse of server resources and software components cooperation) (Wegner (1996)). Characteristics such as time, language, cultural features are essential to spread the word.

Regarding specifically to Lean IT, Schmidt (2009) listed the following types of waste within IT operations:

1. **Overproduction:** when unnecessary applications or IT services are produced and there is no add value to the process flow; that will increase costs for datacenter space, energy and maintenance;

2. **Over processing or non-add-value processing:** miscommunication between business managers and IT Department with different metrics to evaluate the IT performance (for instance, doing the work better than requested by the customers);

3. **Inventory:** multiple repositories for similar information, unutilized or underutilized hardware or additional server capacity, and so on, increase the costs associated;

4. **Defects:** changes on service or operational level agreements, systems or applications plus different standards for project execution provide poor customer service and consequently, more costs;

5. **Transportation:** hardware or physical software security, documents from process to be audit, issues to solve hardware or software problems must be protected; they are the source and higher capital for an organization supported on IT;

6. **Waiting:** slow applications response times and no manuals with procedures to begin processes flow or to solve a problem reflects on a poor customer service and loss of productivity;

7. **Motion:** problems with fires, floods and security within IT infrastructure and applications.

Furthermore if human resources capabilities to innovate or make changes are not part of organization culture, it will reflect on talent leakage, increase of low job satisfaction and maintenance costs.

Also, according to Poppendieck & Poppendieck (2006) and Hibbs & Jewett (2010) the reason of Lean IT is to discover waste, reduce costs and make IT products more effective. There are specific wastes for software development. Types of waste were inspired by the seven production wastes from Shigeo Shingo and are related as shown next at Table 1:

Production	**Software Development**
Inventory	Inadequate Work
Overproduction	Extra Functionalities
Over processing or non-add-value processing	Relearning
Transportation	Transfer Control
Motion	Task Switching
Waiting	Delays
Defects	Failure

Table 1 – The Seven Wastes

Source: Poppendieck, M. & Poppendieck T., 2006, p.93

1. Inadequate Work: is stock unnecessary. System value flow should comprise encoding, tests, reports and delivery. It is appropriated to work in batch or iterations. Inadequate work examples are: documentation still not coded, code not synchronized or not tested;

2. Extra Functionalities: features that or not in use and or not necessary to do the work (extras).

For instance, create a framework for a speculative application is not a good idea because usually it represents record of failure;

3. Relearning: it is essential to leverage the knowledge of every human resource, drawing on the expertise they have built over time;

4. Transfer Control: it is usual to loose knowledge (tacit knowledge is difficult to be reported). What it is possible is to minimize waste. For example, reducing the transfer number using direct observation, interaction with models, prototypes or simulations. Another way is ask for feedback during the process;

5. Task Switching: generates distracting, time consuming and often worsening results of both tasks. Perform multiple tasks at once usually makes no sense and causes delays;

6. Delays: to reduce delays it is not important the team physical location. Instead, it is necessary to make sure that knowledge is available exactly when and where it should be used;

7. Failure: encoding should include tests failsafe that does not allow defects in code. It is important to find unexpected failures as soon as possible and test it (costs increase with time).

When all the wastes are eradicated or decreased, the organization should continuously control the processes and try to integrate optimization on the delivery service or product (that could also be software).

In the article "Reshaping IT management for turbulent times" from the consulting firm McKinsey & Company and elaborate by Roberts et al. (2010) and cited by Orzen et. al (2010), two categories of Lean IT are specified:

1. "Enabling IT": to implement innovation and acquire competitive advantage, IT workgroups are attached to several areas – support experimentation, collaboration and data mining;

2. "Factory IT": to accomplish improvements, Lean management techniques and the process flow should be integrated at the same package. Two other perspectives that can help on this category are: Cloud Computing and software development.

Bell & Orzen (2010) described also, two different dimensions:

1. Outward-facing Lean IT: Engaging information, Information Systems, and the IT organization in partnership with the business to continuously improve and innovate business processes and management systems;

2. Inward-facing Lean IT: Helping the IT organization achieves operational excellence, applying the principles and tools of continuous improve.

Bell & Orzen (2010) and Bell (2012) reflected that cost reduction is natural to Lean products but is not the primary goal. Value creation adopts iterative cycles of learning (PDCA cycle on Illustration 5).

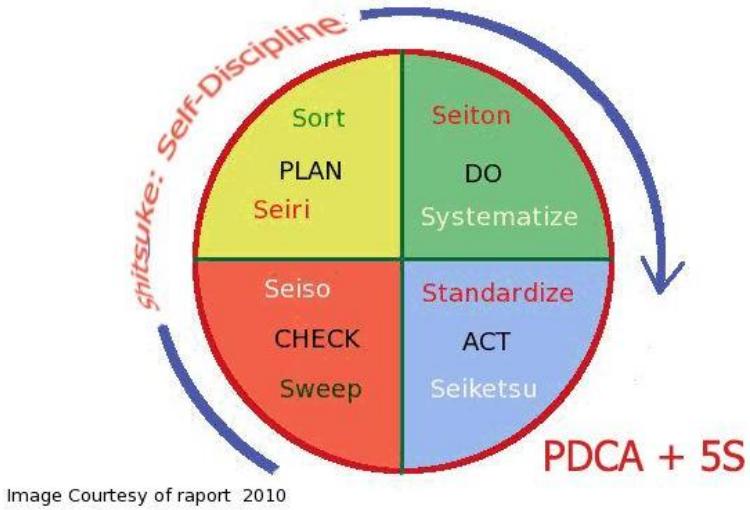

Illustration 5 – PDCA-5S Cycle

Source: Orticio, R., 2010

The process improvement is detected when the right information is delivered at the right time and format, to the customer. When a process standard is created, that will increase the efficiency. The information system should be designed to align the process and the process flow that it should adopt (White et. al (2008)).

According to Aitken (2010, p.7), *"it is the responsibility of management to ensure that new IT process automation plans are driven by improved process control and management standards"*.

Process optimization tools are established by developments in workflow and Business Process Management (BPM). Aalst et al. (2003, p.1) refers that *"Business Process Management (BPM) includes methods, techniques, and tools to support the design, enactment, management, and analysis of operational business processes. It can be considered as an extension of classical Workflow Management (WFM) systems and approaches."*

Policies and standards should be applied on the processes' development. According to their achievement, right decisions must be established, measured and controlled.

Measures and controls (techniques such as VSM, Pareto or Fishbone Analysis, *Poke Yoke* reported by Aitken (2010)); Just In Time (JIT is to make only what is needed, when it is needed and in the amount needed); *Kanban* (means signalization card in Japanese and it is the way to control the material flow; the challenge is to control the card content with the appropriate location (Cunningham et. al (2007)); *Jidoka* (automation with a human touch)*; Heijunka* described by Haaster et. al (2010) or even *Kaizen* (representatives from different functional areas attempt to work together and solve organization problems (Caseau (2011), Cunningham et. al (2007))), A3 Thinking, *Kaikaku* and Standardized Work analysed by Bell & Orzen (2010)) need to be adjusted to the specific risks aggregated in each process.

When the risk is high, the focus must be on mitigate or eliminate such probability.

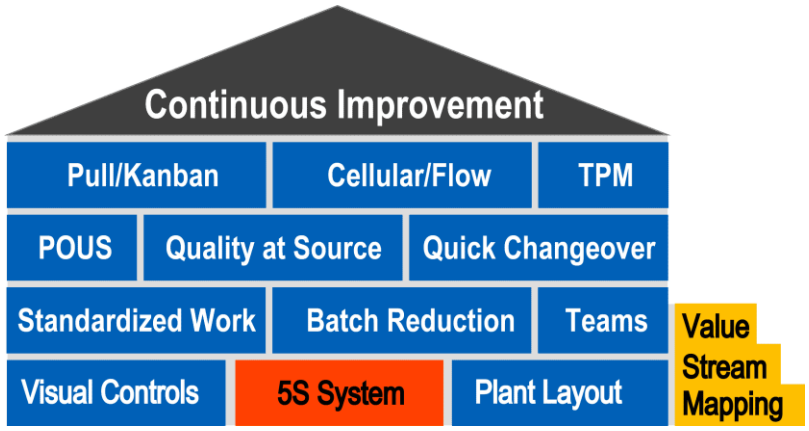

Illustration 6 – House of Lean

Source: Citynetevents, 2012, p.1

Illustration 6 is an example of metrics that can help to improve the business.

All these techniques are largely used on production industry or even on services' processes but in IT field it is more difficult to specify IT attributes as resources to be measured or controlled.

Orzen (2011, p.5) specifies that *"IT enables people to solve problems and create value. Information is primary and functionality is secondary"*.

Raichura & Rao (2009, p.2) argues that *"…despite heavy investments by organizations in IT, there is a huge gap between what businesses expects from IT and what IT can deliver-back to the business"*.

There are fewer experiences and examples of techniques applied on IT applications (IT teams, Software, Hardware, Storage, Data Centers and so on). 5S/6S Technique seems to be the one that is more applied on IT environments because it can be applied on physical and/or logical environments. 5S/6S Technique organize the workplace and is not aggregated to any particular business. It should be taken in consideration in any field.

2.2.1. 5S/6S Technique

5S/6S is a technique and management approach that results from a well-organized workplace with visual controls and brings efficiency to any work environment. It was developed by Hiroyuki Hirano (1995) in his book "5 Pillars of the Visual Workplace" (1st book edition was in 1990).

There is a place for everything and it should stay clean, uncluttered, safe and organized. Human resources and process should be linked and the product adopts a process flow since it is requested, to the final delivery (Bresko (2009), Caseau (2011)).

The technique should engage all human resources to accomplish and contribute to the organizational culture change. It is not just a manufacturing tool. It could be applied in different office settings and it requires perseverance and determination, attention to details and the ability to separate what is really important from what is waste.

This technique aggregates some principles from time management (time is a crucial asset and it must not be wasted in unnecessary effort) and physical work space area.

Focus seems to be set for the workplace but it is not all we can accomplish. Focus should be also on work process that is being executed on that specific workplace.

Initially, it is necessary to identify the work process in study and what benefits are going to be provided through that.

The 5S/6S' technique includes five Japanese words that symbolize the five tenets of good housekeeping (Illustration 7). They are described in Hirano (1995), Roll (2005), Philbrick (2008), McMahon (2008) and Bell & Orzen (2010):

- ***Seiri*** (Sort): remove all the items that are not needed to the current operation; items that are necessary to the functioning of the work must continue on the process flow, however, they must be split in two groups: those which are regular used and occasional used. Any item should be tagged with its information and position so an item/tool could be for example, a software program;

- ***Seiton*** (Set in Order/Straighten): establish location to items they are usually on the process flow. It is a technique to reduce the distance and timing of searching. Visual controls should be created (visual Scoreboard, *Jidoka* lights, floor paint, *Kanbans* and so on) so that others can follow the same efficient workflow;

- ***Seiso*** (Shine/Scrub/Sweep): clean the entire area usually implements a more positive attitude on human resources and increases the productivity. It also helps to detect leaks and problems with equipment more quicker;

- ***Seiketsu*** (Standardize/Systematize): create new habits and levels of performance expectations, which should be easy to understand, communicate and prevent constant maintenance. The goal is to keep everything that is necessary and ready to use;

- ***Shitsuke*** (Sustain): establish schedules and systems to maintain the rules that were previously adopted and became a routine. All human resources must be properly trained and understand how tasks could be continuously improved;

- **Safety** (the 6^{th} S): it is inherent of every past S words and intertwined with all of them.

5S/6S is a cyclical methodology: sort, set, shine, standardize and sustain, always looking for safety, complete the cycle (Appendix 1 demonstrates an example of 5S/6S Technique form and related questions to each S techniques).

Some organizations established a sixth S called precisely, Safety. That is why sometimes the technique is also called 6S (Roll (2005)).

Illustration 7 – 5S/6S Technique

Source: EPA – United States Environmental Protection Agency, 2011, p.1

The methodology allows collaborators to control their environment, reducing time spent in searching for documents, tools or applications.

According to Hirano (1995), Philbrick (2008), McMahon (2008) and Saxena (2009) some benefits from 5S/6S Technique are:

- Directly improves productivity, performance, morale and self-discipline;

- Makes cleaner and safer work area which increases credibility with customers, suppliers and visitors;
- Reduces the amount of time wasted in unnecessary resources and costs related;
- Visual tools can be used to raise the understanding of proper waste handling and management procedures;
- Good technique implementation on a team or department is usually an indicator of probable success at the whole organization.

Because Lean has some purposes like: eliminate waste (waste in search, travel, transporting materials and so on) and maximize value-added to each process it is necessary to pay attention to them.

Value should be readily grasped because there is a place for everything and everything has a specific place to be attached. Also, because people get involved on their own work settings, this technique creates a huge sense of achievement.

To be implemented, 5S/6S Technique has 3 phases approach (according to Roll (2005)):

- **First** is to get ready to the event. The major steps are to understand the customer expectations, build a document with the references, define goals, understand if the events makes sense on the process flow and match between people and tasks;
- **Second** is to take action according to what was established before the event. To start the event, one team should be prepared to process the information, locate waste, generate improvement ideas and select the best ones;
- **Third** is to make sure that improvements are sustained and controlled. Also, improvements should be analysed so that parameters could be perfectly understood and executed in the future.

Another approach largely admitted is to establish 5 implementation levels (by Leading Edge Group (2012)):

- **Level 1:** Just beginning;
- **Level 2:** Focus on basic;
- **Level 3:** Make it visual;
- **Level 4:** Focus on reliability;
- **Level 5:** Continuously improve.

Usually it is used to building teams who share the same workplace and to measure this technique achievement it is necessary to look at each component and understand how each level or phase (according to the approach adopted) is being worked.

According to Popescu et. al (2010), human resources should be able to identify anything necessary in their workplace in less than 30 seconds which widely increase the answer time. That is the key points for a well succeed implementation of 5S/6S Technique.

2.3. Chapter Synthesis Section

After reviewing literature regarding to Lean concepts, IT perspectives and existent techniques that are actually used to describe, analyse and represent (most of the time) improvements on the process workflow of different sectors, it is time to focus on the chosen technique to this particular Case study: 5S/6S Technique concerning to the 5 implementation levels described in Chapter 2.2.1.

Unlike the 3 phase's approaches that are not exclusively reported in any statement, analysis or book (they are open perspectives that can be adjusted to any environment) with 5 levels it is possible to use a form elaborated by Leading Edge Group (Appendix 2: Five S Work Area Form) that helps the author to visualize (through systematic observation) and simultaneously describe what is happening in each phase of the process flow.

This method takes in consideration on each level, all "S" words introduced on 5S/6S Technique (standards/steps): sort, set in order, shine, standardize and sustain (Chapter 2.2.1).

It is important to understand the level that the organization has been working on and then, move forward to achieve better results.

Previous concepts are expected to prove the real impact of Lean and its techniques on an IT environment and what should be necessary to model and design the best development process, not adding unnecessary value and corresponding to customers' needs.

3. Methodological Approach

This chapter includes an approach about the research methods and their applicability.

As a first perspective it will analyse the differences between qualitative and quantitative methods and why the dissertation was driven to the qualitative ones. To start this methodological perspective it is important to clarify the definition of research.

To establish a methodology it is necessary to understand how the search for particular topics and answers is done. It includes the references to the theoretical addressed issue and the associated analysis tools (Hoppen et. al (1996)).

Research is to find a solution to a specific problem based on rational and systematic procedures. It is an operation that cannot be controlled or predicted therefore, the adoption of a particular methodology depends on the chosen path (Murtonen (2005)).

As singled by Galliers & Land (1987, cited by Hoppen et al., 1996) the choice of a research method depends on the object to be studied so as the knowledge, skills and preferences of the author.

For Minayo (1995, cited by Silva & Menezes, 2005) research is also a phenomenon of successive approximations to reality which fits the theory and the data involved.

Adds Demo (1996, cited by Silva & Menezes, 2005) that research is an everyday activity that questions systematically, to establish a critical intervention and with theoretical and practical sense on the subject.

Research criteria's must define scientific accuracy so that the conclusions add value to an Information System domain (referring to Information System in this context as the subject related to the dissertation thematic).

But the quality of research cannot be based simply on methodological choices that were applied on the study. Criteria's and weighing are also very important to analyse and summarize the thematic (Wainer (2007)).

According to Luna (1988, cited by Silva & Menezes, 2005) to investigate it should exist a problem to solve, the development of steps to discover one or more solutions and the degree of reliability in response.

Also related to Silva & Menezes (2005), the planning and implementation of research adopt a process flow: choice of topic, literature review, formulation and justification of the problem, determine the research objectives, methodologies, data collection, processing, analysis and data discussion and conclusion draw from them.

As a perspective of the steps that should be learned and adopted, Information & Research Instruction Suite (IRIS) (2009) published an article to teach how to do a research process and a way to organize the search for information.

The article explores the follow steps illustrated bellow on Illustration 8:

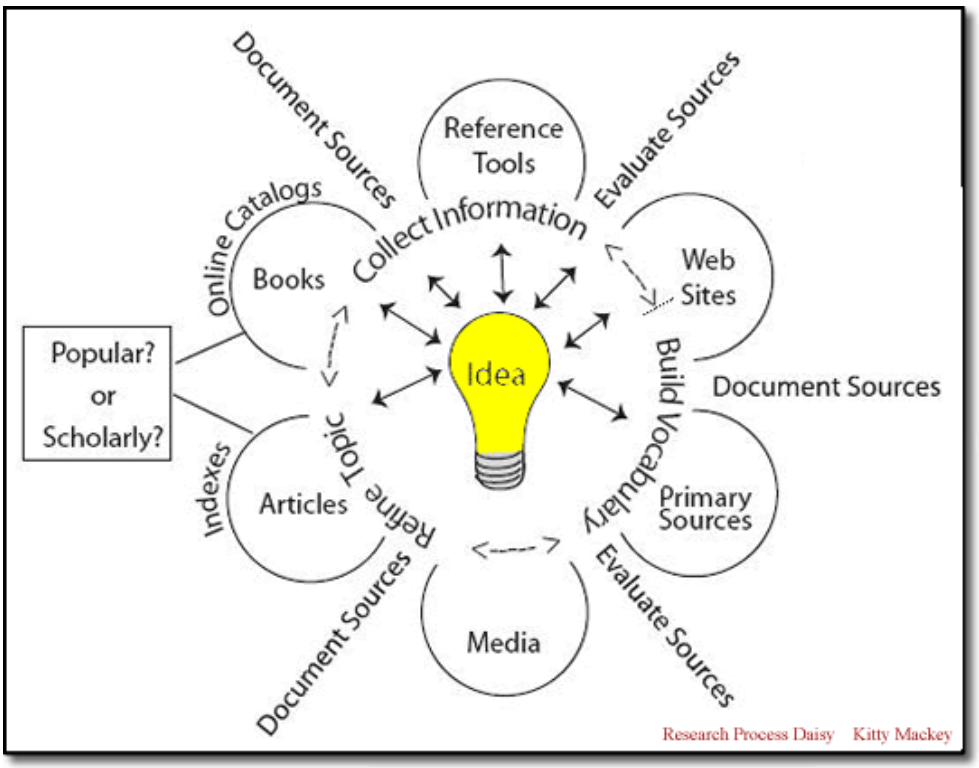

Illustration 8 – Process Way to Search for Information

Source: Information & Research Instruction Suite, 2005, p.3

In order to structure the research it should be classified by its approach. As described by Silva & Menezes (2005) it is possible to research:

- Taking into account the research nature: generation of new knowledge that is useful to science but where there is no practical application provided or apply the practical applications of knowledge to generate and specifically, solve a determined problem;

- Considering how to approach the problem: quantitative based on experimentation and quantification of data that is translated into numbers which can elicit views and information for analysis and results' classification that also uses statistical techniques such as mode, media, standard deviation etc, for the correlation analysis' between the available variables. Also qualitative in sense of a research that is focused in a thematic and does not employ a statistical tool for data analysis that is descriptive. Its primary objective is the process and its interpretation, which is used to find and open space to the perception and interpretation of concepts.

- Corresponding to objectives (Gil, 1991, cited by Silva et al., 2001): exploratory (understand the problem in order to make it explicit or build hypotheses through it; literature searches or case studies on the established thematic), descriptive (uses standard techniques for collecting data about a given population or event; these techniques can be questionnaires or systematic observation) or explanatory (identify the factors that establish the occurrence of a certain event; usually works with experimental searches or Expost-Fact);

- Finally, regarding technical procedures: literature (through the analysis of books, articles, newspapers, magazines and content available on the Internet), documentary (for content analysis that does not follow an analytical line for data treatment), experimental (an object is tested according to established variables and also defines forms of control and observation of achieved results in the implementation of those variables in specific objects), survey (suggests a direct contact with the human resources allocated to the problem analysis), Case study (study of a subject in an exhaustive way in order to increase knowledge on the subject in question), research Expost-Fact (when tests are performed after the facts), action research (for the establishment of a collective solving problem in which the participants of the resolution are also, actively integrated in the problem) and participatory research (where there is interaction between authors and the team involved on the subject).

"The qualitative methods consist of a set of techniques' interpretations that are targeted towards to retrace, decrypt or translate natural social phenomena, in order to obtain relevant evidence to describe or explain these phenomena." (Van Maanen, 1983, cited by Hoppen et al., 1996, p.19)

Based on scientific perspectives, qualitative methods consist on a set of the following characteristics (Günther (2006)):

- Try to find answers from a predetermined question;
- Use a predefined set of procedures to answer the question that is being investigated;
- Search for evidences, case studies and interpretations about the thematic;
- The search seeks for new perspectives' approaches that can or cannot be applicable on a certain domain.

Qualitative methods aim to express the meaning of the phenomena and reduce the discrepancy between theory and data.

Theory is still a huge perspective but the major aim is to provide new theories and perspectives. The main research instrument for qualitative methods is the author. It is her/his point of view that will personalize the investigation and its conclusions.

As specified by Bowen (2005, p.219), *"In qualitative research, findings do not result from statistical procedures, correlations, and similar mathematical calculations; instead, they come from an interpretation of non-numerical or largely text-based data. Yet, numerical data have a place in qualitative studies; they should be included where available and where appropriate."*

To quantity it should be validated by a past theoretical knowledge about the subject because the thematic has been already studied (Sutherland et. al (2011)). Hypotheses are formulated after the theory and they should be the more general as possible so that they would not be directly assumed as a specific case explored before.

Quantitative research is concerned with counting and measuring data, producing evaluations about a determined group and its aim is at explanation. Those phenomenon expressed in numeric terms are analysed by statistical methods.

Indeed, *"Unlike quantitative research, qualitative methods face interaction with the researcher's field and its members, as a whole part of the explicit production knowledge, rather than exclude them as participant variables from the research. The researcher subjectivity and the subjects studied are part of the research process."* (Flick, 2005 cited by Duarte, 2009, p.7).

The illustration bellow (Table 2) summarizes the research aspects between qualitative and quantitative methods: purpose, approach, data collection approach, author independence and samples.

Comparing Qualitative & Quantitative Research		
Qualitative Research	**Research Aspect**	**Quantitative Research**
Discover Ideas, with General Research Objects	**COMMOM PURPOSE**	Test Hypotheses or Specific Research Questions
Observe and Interpret	**APPROACH**	Measure and Test
Unstructured. Free Form	**DATA COLLECTION APPROACH**	Structured Response Categories Provided
Research is intimately involved. Results are subjective	**RESEARCHER INDEPENDENCE**	Researcher uninvolved Observer. Results are Objective
Small samples – often in Natural setting	**SAMPLES**	Large sample to Produce Generalizable Results [Results that Apply to Other Situations]

Table 2 – Comparison between Qualitative and Quantitative Research

Source: Shaya'a, O., 2011, p.1

The qualitative and quantitative methods can be combined in different ways in the same research. Both of them can be applied to describe a social reality (Neves (1996)).

Comparison of Quantitative and Qualitative Research Approaches		
	Quantitative	**Qualitative**
General Framework	Seek to confirm hypotheses about phenomena	Seek to explore phenomena
	Instruments use more rigid style of eliciting and categorizing responses to questions	Instruments use more flexible, iterative style of eliciting and categorizing responses to questions
	Use highly structured methods such as questionnaires, surveys, and structured observation	Use semi-structured methods such as in-depth interviews, focus groups, and participant observation
Analytical Objectives	To quantify variation	To describe variation
	To predict causal relationships	To describe and explain relationships
	To describe characteristics of a population	To describe individual experiences
		To describe group norms
Question Format	Close-ended	Open-ended
Data Format	Numerical (obtained by assigning numerical values to responses)	Textual (obtained from audiotapes, videotapes and field notes)
Flexibility in Study Design	Study design is stable from beginning to end	Some aspects of the study are flexible (for example, the addition, exclusion, or wording of particular interview questions)
	Participant responses do not influence or determine how and which questions researchers ask next	Participant responses affect how and which questions researchers ask next
	Study design is subject to statistical assumptions and conditions	Study design is iterative, that is, data collection and research questions are adjusted according to what is learned

Table 3 – Comparison of Quantitative and Qualitative Research Approaches

Source: Mack, N. et al., 2005, p.3

Another study care out by Mack et al. (2005) (Table 3) expressed comparison of quantitative and qualitative research approaches through its general frameworks, analytical objects, the question and data format adopted and the method flexibility when faced with the correlation between study and participants.

As Bowen (2005, p.208) declared, *"researching and writing a dissertation – particularly one based on qualitative research methods – demand a different set of skills and offer some special challenges because of its nature and scope."*

Qualitative research adopts an in-depth investigation with the emphasis on maximize the information about a specific topic.

That is the challenge facing the qualitative methodological perspective for a dissertation thematic.

According to the types of research methodologies studied before and thinking about the general and specific objectives related to this paper work and the problem observed (waste and non-add value to processes), the proposed methodology is the qualitative approach based on investigation issues and a Case study.

With previous methodological approach represented on this chapter, the methodology adopted considering how to understand the problem is the qualitative research with focus on data analysis.

According to Yin (2002) design and methods and the chosen SME, **single case study** is the approach technique. The objective is to describe the object through systematic observation supported by organization documentation and archival records (evidences), focus on an IT Department (Comer (2012)). The units to be analysed are computers, workstations and software development (projects).

For work completion, the chosen methodological approach was to run a Case study based on direct observation with forms that helps the author to observe, analyse and later on, understand certain work standards.

To Yin (2002), case study is one of several ways to achieve social science research. This approach is used in many and different situations and contribute to increase our knowledge of various kind of phenomena.

4. Case Study

To Strauss & Corbin (1998) most of authors use qualitative methodology probably hoping that the work could have impact or potential relevance for both academic and nonacademic environment.

Usually a Case Study goes beyond simple and easy observation and testimonials. It represents real examples of how organizations can accomplish their goals and, at the same time, satisfies their customers (Duarte (2010)).

To understand relevant situations for a Case Study research strategy, Yin (2002) proposes to explore questions like “how” and “why” in order to establish certain values in contemporary events.

Following the same thought line, this Case Study represents a real organization, with its activities and daily routines for provided IT services (projects and software development).

The information included in this chapter takes part of SME archival records, documentations and website (examples of source evidences described by Yin (2002)).
These were the sources of evidence allowed by the company (described in Table 4).

Sources of Evidence	Examples
Documentation	Letters, memoranda, agendas, minutes of meetings, other written reports of events, proposals, progress reports, formal studies, evaluations, newspaper clippings and so on.
Archival Records	Computer files, service records (number of clients), organizational records (charts and budgets), maps (layouts), list of names, survey data (census records), personal records (calendars, diaries) and so on.
Direct Observations	Observe relevant behaviors or environmental conditions, meetings, sidewalk activities, factory work, classrooms and so on (passive observer).
Physical Artifacts	Technological device, tool or instrument, work of art, physical evidence and so on.

Table 4 – Important Sources of Evidence

Source: Oneself adapted from Yin, R., 2002, p.85-96

Since its debut in Information Systems and Innovation Management, SME has been working on several projects and areas such as: outsourcing, document management, innovation, consulting, business intelligence and portals.

Mission: develop innovative solutions in the areas of Information Technology, advance Communication Design and contribute toward development of customers, partners group and employees.

Vision: to be a reference point and a source of innovation in the Information System, technology and innovation area.

The **values** associated with this SME are:

1. Promote respect, responsibility, team spirit and human development and professional employees;

2. Assist and contribute to ensure the effectiveness and improve the efficiency of the SME customers and partners;

3. Social Responsibility and sustainability;

4. Culture of innovation and future technology perspectives.

SME service solutions are established between Design and Communication (websites), IT services (i.e. Business Intelligence (BI) and Customer Relationship Management (CRM)).

This organization has two hierarchical levels (Illustration 9) with a total of 11 employees, including top management. Note: the number is variable because it depends on projects' dimension; human resources can be from Outsourcing environment):

- Top Management: the owner;
- IT, Finance and Human Resources Departments (2 Department Chiefs).

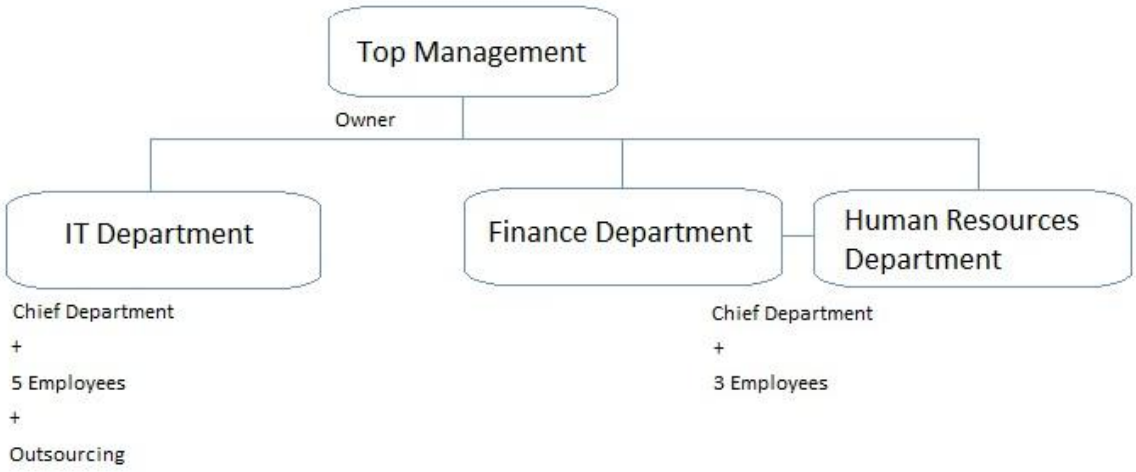

Illustration 9 – SME Organogram

Source: Oneself, 2012

With the present time crisis and impact of new forms of technology on any organization daily work, the SME top management is interested in further necessary changes to methods which may help to improve the organization skills and achievements.

Working on different technology environments, the SME must use only what is essential to accomplish the standard established and agreed in the early meetings with customers and meet the deadline.

As a first approach the IT Department was chosen to start implementing Lean concepts and 5S/6S Technique. The choice was made because the study provides the use of Lean techniques related to Information Technology and it works with the core business of the organization.

To start and prepare the Case Study, the first step is that the author meets with the top management and with the responsible for the IT Department to identify what is expected for the event; however this work is usually performed by a team of experts in Lean methodologies. In this particular case the author is the responsible to present the case, share perspectives, concepts to be learnt and produce the Case Study. It should be seen as a singular form of management implementation.

This particular department is an open space area where 6 employees are constantly discussing about new projects, deadlines and improvements on their work.

There is no boundary about what specifically each one of them should work on, which equipment is important to complete their tasks and there is no implemented desktop/archival standard so that anyone involved on a particular project has immediate access to security copies, documents and developed code (if it is a software development project).

The first contact should be to explain to the IT Department personnel why it is so important to try new methods to improve their work. Resistance to change is critical to achieve goals and future work perspectives.

After introducing some Lean concepts, the author explains what is 5S/6S work technique, how is it done, its purpose and benefits and also demonstrates with proof such as pictures or documentation of previous work areas where this technique was already used.

Untidy workplace areas seem obviously waste but what it is not so obvious is that it also affects business performance. When we detect and measure how waste affects the operations we can also estimate the cost associated and the price of keeping specific waste on the process flow. And it is fundamental to remember that to eliminate or decrease waste is one of the pillars of Lean.

It is also important to set a list of rules so that human resources will keep doing their work without external interference.

After technique implementation and results analysis (Chapter 5.1.1.), we shall expose the conclusions and future work perspectives with 5S/6S Technique in Chapter 6, including new approaches to other departments and top management.

5. Data Analysis and Discussion

Author is the main process manager used for the analysis of a Case study. This instrument makes use of its intuitive function to do detailed analysis, recognize the influence of context, investigate and focus on the problem at and.

Another important function of systematic observation is interpretation and its goal is to reformulate the case according to the process flow and seek for improvements.

After systematic observation and consultation of the archived records, *author* must be able to apply the "Five S Work Area Form" (Appendix 2):

- Level one: "Just Beginning";
- Level two: "Focus on Basics";
- Level three: "Make it Visual";
- Level four: "Focus on Reliability"; and
- Level five: "Continuously Improve".

However, it should be noted that to achieve all five levels a large amount of time is necessary, improvements are incrementally brought to the organization and future results measurements are time consuming. Therefore, in order to achieve relevant results within the time-frame of this project, the "Five S Work Area Form" was applied up to level three. In other words, the results obtained from this analysis reflect the current position and strategy of the organization according to the application of the "Five S Work Area Form" from level one to three.

5.1. Case Study: Application of 5S/6S Technique in a SME

According to Yin (2002) there are at least 6 forms of evidence for a case study (Table 4, Chapter 4). For the purpose of this project, and after previous literature review about 5S/6S Technique, the case study was divided in three main parts that enabled the analysis of the SME: documentation and archival records, systematic observation and application of 5S/6S form. Please note that due to confidentiality issues, some information regarding this SME could not be displayed in this document at this time (some illustrations are not readable).

Documentation and Archival Records

The first step to be carried out is data collection. For this purpose, it is detrimental that *author* understands how the IT Department works and what substantial references exist that enable the distinction of standard projects and software development.

Author should further analyse the methodology applied to accomplish the cycle time established for each project or software development and verify if all documents are used according to each project specifications.

Most of the IT Department information is available in an unlocked cabinet (Illustration 10). Therefore, everyone (within the organization) can have access to documentation, processes and information about the developed projects (Information Commissioner's Office has data protection and security measures for organizations, personal data or official information for the public that should be adopted on IT organizations). Furthermore, there is little content in digital format and there is no control over the accessibility of certain files.

Illustration 10 – Cabinet with Archival Records

Source: Oneself, 2012

Systematic Observation

At this stage of the case study it is important to develop a workplace layout, take pictures of the area (to compare between before and after the application of the technique) and identify where the highest visual waste in the process flow is (i.e.: in individual workplace organization). Then, for the identification and understanding of the location of major problem, 6S evaluation (Appendix 1) is applied.

From the first evaluation of the IT Department, August 2012, the following was observed:

- In general, Sort (Organization), Stabilize (Set in Order / Orderliness) and Shine (Cleanliness) are the most problematic areas. There is a necessity to remove some superfluous items and identify accurately all work areas and work procedures;
- Several problems arose when posing the following questions: *Have all unnecessary items been removed*? *Is there a place for everything*? *Are work areas, equipment, tools, desks clean and free of debris, etc.*?;
- The non-problematic areas were: employees adhere to changes, there is a system and audit feedback in place and the safety equipment is well identified and accessible providing zero incidents.

One of the identified areas in need of a possible reorganization was the computer screen, as it should only be visible what is necessary to work and respond to certain procedures (Illustration 11).

Illustration 11 – Personal Computer Screenshot

Source: Oneself, 2012

Illustration 12 demonstrates the first 6S Evaluation. It shows how the work area was organized before 5S/6S technique implementation through systematic observation.

6S Area: IT Department		Item Score	
		Before	After
Sort (Organization)	**Distinguish between what is needed & not needed**		
	Have all unnecessary items been removed?	2	
	Are walkways, work areas, locations clearly identified?	1	
	Does a procedure exist for removing unneeded items?	1	
Stabilize (Orderliness)	**A place for everything and everything in its place**		
	Is there a place for everything?	2	
	Is everything in its place?	1	
	Are locations obvious and easy to identify?	1	
Shine (Cleanliness)	**Cleaning and looking for ways to keep it clean**		
	Are work areas, equipment, tools, desks clean and free of debris, etc.?	2	
	Are cleaning materials available and accessible?	1	
	Are all aisle markings, location indicators, etc., clean & unbroken?	1	
	Cleaning schedules exist and are posted?	1	
Standardize (Adherence)	**Maintain & Monitor for adherence**		
	Is all necessary information visible?	1	
	Are all standards known and visible?	1	
	Are all visual displays current and up to date?	1	
	Is there adherence to existing standards?	0	
Sustain (Self-Discipline)	**Following the rules to sustain**		
	Are procedures being followed?	1	
	Does an on-going audit and feedback system exist?	0	
	Does a system exist to respond to audit feedback?	0	
Safety (Zero incidents)	**Maintaining a safe work place**		
	Is a green tag system in place?	1	
	Are appropriate controls in place to identify safety equipment?	0	
	Is all safety equipment unobstructed and accessible?	0	
	Total Score	18	
Evaluators Name: Researcher	Scoring: 0= No problems 1= One to Two problems 2= More than Two problems		

Illustration 12 – 6S Evaluation: Phase One

Source: Oneself, 2012 adapted from Roll, D., 2005

From Illustration 12 it is visible that the total score for phase one of the 6s Evaluation is of 18, this is not bad, but it could be improved. Although, there was already a notion of organization of documentation and keeping visible and safe what is important, some problems still need to be removed to improve the process flow. The aim is to reduce the number and try to have a cleaner organization with less wastage.

In order to compare the impact of the 5S/6S technique on this particular IT Department, the same 6S Evaluation was carried out after the application of the "Five S Work Area Form" (levels one, to three), enabling the visualization and measurement of the differences between the before and after the 5S/6S implementation..

Five S Work Area Form

Each level of the "Five S Work Area Form" studies the 5S methodology: Sort (*Seiri*), Set in Order (*Seiton*), Shine (*Seiso*), Standardize (*Seiketsu*) and Sustain (*Shitsuke*). Note that the sixth S (Safety) is reflected on the other S perspectives and that it is always inherent to each step of the process.

Examples of the 5S methodology are as follows:

- *Seiri*: organize workstations objects, data servers, software versions, archived records, old reports, security copies and reduce code (when, in developed software, code, variables, methods, functions and classes that are unutilized can be found);
- *Seiton*: organize projects according to workstations layout, archival structure, reduce dependencies and layout for common workspace area;
- *Seiso*: clean physical workspace area and archival records on developed software that is crucial to solve failures and bugs on tests;
- *Seiketsu*: reduce complexity through the cycle time to facilitate posterior maintenance, safe copies on a constant basis and build patterns for workspace area; workstation should only have the essential resources to execute a determined project;
- *Shitsuke*: maintain discipline using standard procedures.

Prior to the 5S/6S evaluation, an introduction was given to top management and IT regarding this dissertation proposal to solve some management problems through Lean techniques. After one week it was approved that the IT Department could be used as a case study.

During this period there was a continuous exchange of information about Lean examples and other case studies (mostly in industrial environments).

The first "Five S Work Area Form", level one was applied in August 2012 (Illustration 13).

Five S Work Area Form

Level One: "Just Beginning"

Standards/Steps	Owner	Date
Sorting Level 1:	Researcher	
Needed and not-needed items are mixed throughout the work area.		
Obtain a layout for work area and mark 5S boundaries	√	August 2012
Obtain a (digital preferred) camera and take baseline photos	√	August 2012
Assign work group members to their 5S areas	√	August 2012
Identify a place to put not-needed items	√	August 2012
Obtain cleaning supplies	Outsourcing	August 2012
Simplifying Level 1 (Set in Order):		
Items are placed randomly throughout the workplace.		
Clarify boundaries of individual work stations and common areas	√	August 2012
Clarify who is responsible for different work are locations and common areas	?	August 2012
Obtain existing standards for color-coding	?	August 2012
Obtain markers, tape and foam for outlining and color-coding	?	August 2012
Obtain wood, foam, and other supplies for shadow boards	?	August 2012
Systematic Cleaning Level 1 (Shine):		
Key work area items to be checked and not identified and are unmarked.		
Determine communication and decision making for work areas involving multiple shifts	√	August 2012
Determine other groups to coordinate and communicate with while determining key items to be checked for the work area	?	August 2012
Determine location of equipment manuals and procedures	√	August 2012
Standardizing Level 1:		
Work are methods are not consistent followed and are undocumented.		
Gather lists and diagrams of daily cleaning responsibilities	Outsourcing	August 2012
Identify workplace methods currently used	?	August 2012
Sustaining Level 1:		
Work area checks are randomly performed and there is no visual measurement of 5 S performance.		
Designate location for tracking 5S performance	?	August 2012
Evaluate initial 5S Level of Achievement	√	August 2012
Install 5S Communication Board and assign responsibility for updates	√	August 2012
Determine 5S targets, activities and schedule	√	August 2012
Review 5S plans with entire work group and site leadership	?	August 2012

Illustration 13 – 5S Work Area Form: Level One

Source: Oneself, 2012 adapted from Leading Edge Group, 2012

It took two weeks to analyse and work through the different phases that are listed below:

- First phase: present concepts of Lean principles, types of waste, Lean techniques, 5S/6S, games and videos. The training session took two days.
- Second phase: analyse documentation and archived records and systematic observation.
- Third phase: define and identify physical waste and locate equipment in the surrounding area which includes safety equipment, cleaning equipment, and so on.

After the IT Department evaluation it was time to start working on the environment that needs to be transformed into a Lean project. Level one was the first step and its goal was to make employees aware of the IT Department responsibilities and encourage them to look at new ways of thinking about their work, to improve workflow and work environment. It is worth noting that some cleaning aspects, supplies and diagrams of daily cleaning responsibilities are secured through outsourcing.

The completion of level one led to a defined workplace area and an inventory of computers, files, archival records, backups, diagram of responsibility of each project deadline and a communication and decision plan.

The interrogation mark – '?' – on the 5S Work Area Form (Illustration 13) represents the questions that are being reorganized constantly or that are not yet established at this level. For instance, who is responsible for the different work areas locations and what groups are responsible for the communication are not yet represented because the first goal is to elucidate employees, organize workplace and then start to think about procedures and other responsibilities.

One example of waste was found on workplace organization (Illustration 14). Illustration 14 is a typical desktop on this IT Department. Even though, current workplace methods do exist, it can change according to each project (project or software development).

Due to the on-going changes, methods have not yet been completely defined: different types of software development are in different processing stages and a corporate portal was two weeks away being released online due to test phase.

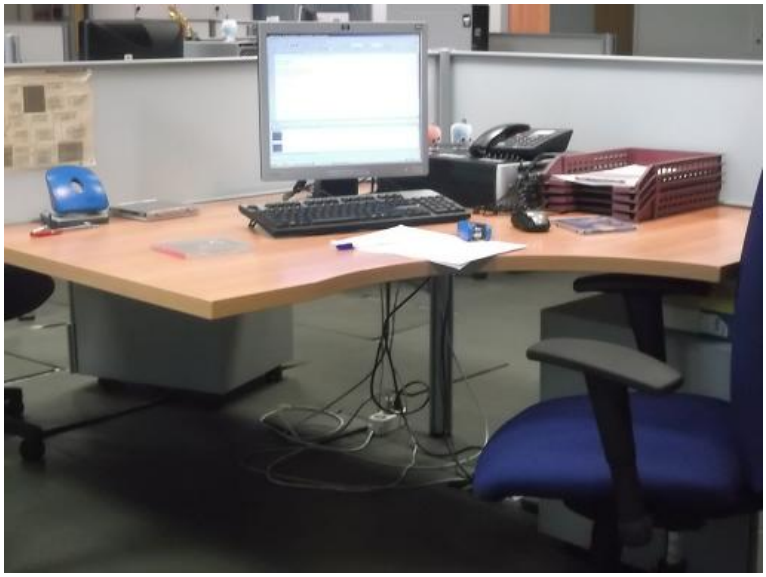

Illustration 14 – Disorganization and Unnecessary Items

Source: Oneself, 2012

Projects and software should be released and compared to enable definition of what is necessary to accomplish tasks, process flow and files.

5.1.1. Results

After applying Systematic Observation via 6S Evaluation and starting to work with level one from 5S Form, it took three weeks to consider and implement some criteria, define whether items were required or not, remove redundant equipment, and determine each item location in the workflow process.

This evaluation began in September 2012 and three phases were implemented in order to accomplish this particular level:

- First phase: logical waste detection on developed projects and programming, and team meeting to consider errors and problems;
- Second phase: documentation perception according to existing projects; integration of tools that provide a structured environment with less waste (project management using Microsoft Excel is not sufficient to eliminate waste and decrease cycle time);
- Third phase: tags (colours or patterns) to locate necessary and unnecessary equipment.

Through Illustration 15 it is possible to visualize that from level one to level two evaluations, Sorting, Set in Order and Cleaning became easier to manage. The challenge was not in visualizing where waste was but in understanding if that waste was necessary or not.

Five S Work Area Form

Level Two: "Focus on Basics"

Standards/Steps	Owner	Date
Sorting Level 2:	Researcher	
Needed and not-needed items are identified and those not-needed are removed.		
Establish criteria for needed and not-needed	√	September 2012
Identify the needed from the not-needed and move not-needed items to designated holding area	√	September 2012
Conduct a white elephant sale	Not Applied	September 2012
Remove excess equipment, supplies, computer files, software and other items not-needed: dispose of unsafe items	√	September 2012
Simplifying Level 2 (Set in Order):		
Needed items are safely stored and organized according to frequency of use.		
Group items and supplies according to use	√	September 2012
Determine a location for each item based on frequency of use	√	September 2012
Systematic Cleaning Level 2 (Shine):		
Key work area items to be checked are identified and acceptable performance levels documented.		
Identify key items to check to ensure proper equipment and process performance	√	September 2012
Determine acceptable performance ranges for key equipment and processes	√	September 2012
Standardizing Level 2:		
Work group has documented agreements for needed items, organization, and work area controls.		
Review 5S documented agreements for needed items, workplace layout, daily checks and acceptable performance with other work areas that will be affected	?	September 2012
Update these agreements and post	?	September 2012
Sustaining Level 2:		
Initial 5S has been determined, and performance is documented and posted in the work area.		
Take work area photos to show improvement	√	September 2012
Evaluate current 5S Level of Achievement	√	September 2012
Document the current 5S level using the 5S Progress Form and post in designated area	?	September 2012

Illustration 15 – 5S Work Area Form: Level Two

Source: Oneself, 2012 adapted from Leading Edge Group, 2012

Items that promote waste but are necessary to the work process flow should have a specific holding area and should only be moved and integrated in the process flow when necessary. If no consensus is achieved on this matter, there will be no improvement in the work process flow and standardization will become very difficult. It is challenging to document agreements and check acceptable Key Performance Indicators (KPIs) if there is no notion of needed items.

Some of the KPIs discussed to evaluate labour costs and possible improvements are:

- Work quality (procedures; software quality);
- Meeting deadlines (planned dates);
- Re-work (coding; information/data not available in time);
- Additional employee effort (wasted non-planned time; re-work);
- Communication issues (technology; remote communication);
- Security risk (standard utilization; logical and physical security);
- Intellectual property risk (loss or gain of knowledge); and
- Organization brand (marketing).

Another concern is with the cleaning management. Employees should be aware of their responsibilities within their work area boundaries. When they gain notion about what is necessary for the work and where it should be located, the process cycle time will decrease because there is no wasted time searching for files, software or records.

Hereafter, when emphasizing the social responsibility value, some items could be donated to aid and solidarity institutions. For instance, unused office computer, equipment and office supplies.

Workplace organization begins with personal employees' desktops. Items are grouped according to frequency and purpose of their use (Illustration 16).

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Illustration 16 – Organization with Necessary Items

Source: Oneself, 2012

There was no previous standard for colour-coding and no one is obliged to use visual colours or markers. If each employee meets the established order through visual code standard which is displayed in Illustration 16 there will be no difficulty to use proper equipment (including software and documentation) from anyone involved in a specific project. And all equipment is accessible in less than 30 seconds. This illustration takes into account an individual workplace with equipment necessary to work on two projects (yellow mark has Digital Versatile Disks (DVDs) with software being used for the development of code) and one portal (green mark has the website being tested). Within blue mark is the documentation that needs to be filled according to each project or software.

In order to progress to level three and prior to making everything visual, it was necessary to work with the head of the development team on standard documents with content about the rules and procedures for each type of project.

The search for templates for standard documents led to a discussion of the advantages and disadvantages of standardizing according to the 5S/6S technique evaluation. Even though, it was not the initial idea and it was not part of the evaluation technique, the ISO/IEC 25010:2011 certification turned out to be a good form of evaluation of the influence of the 5S/6S technique and documentation on this particular IT Department that develops the core product for this SME.

ISO/IEC – Systems and Software Engineering – Systems and Software Quality Requirements and Evaluation (SQuaRE) – System and Software Quality Models (former

ISO/IEC 9126-1:2011 – Software Engineering – Product Quality) analyses and validates the quality model of any IT project, code development and information systems.

The International Standard Organization defines that quality in a used model is related to a product within a particular context. It is applicable to computer system and software products. The use of quality models can benefit activities on product development such as:

- Identifying software and system requirements, design objectives, testing objectives, quality control criteria;
- Validating the comprehensiveness of requirement's definition; and
- Establishing measures to quality characteristics.

The targets of ISO/IEC 25010:2011 quality models are shown by Illustration 17. This would be helpful to coordinate standard documents from the IT Department.

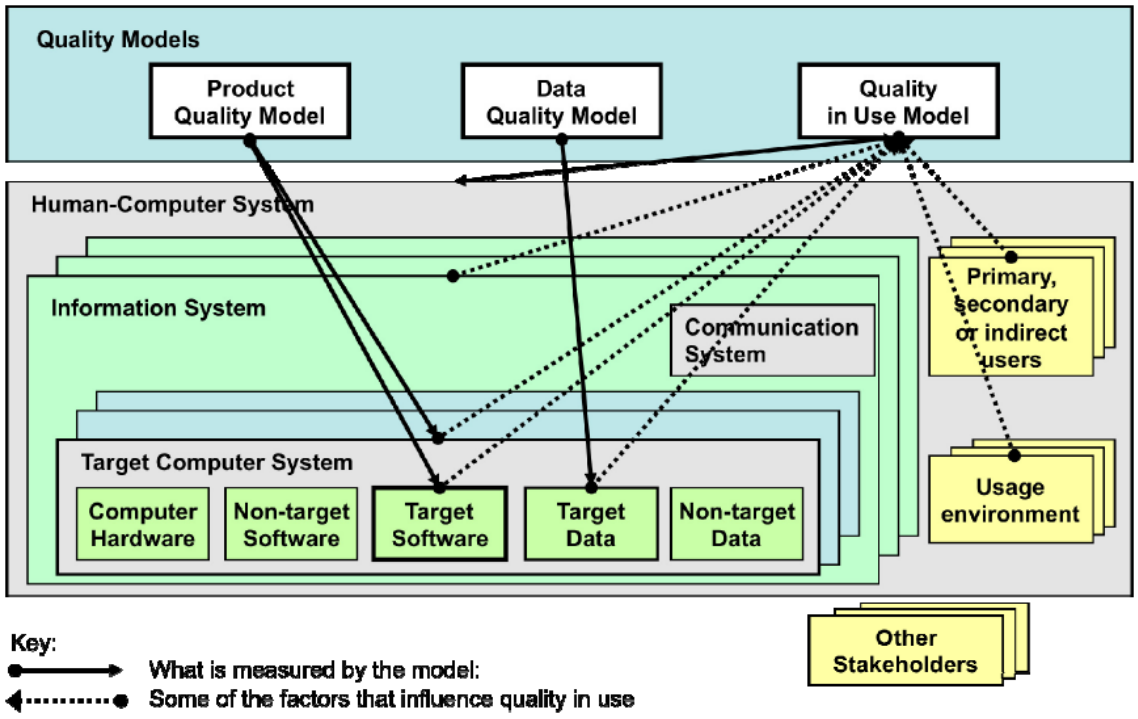

Illustration 17 – Targets of Quality Models

Source: ISO, 2011

According to ISO/IEC 25010:2011 (2011, p.4) *"the product quality model focuses on the target computer system that includes the target software product, and the quality in use*

model focuses on the whole human-computer system that includes the target computer system and target software product".

With 5S/6S evaluation determined by PDCA cycle and standards' approach regarding ISO/IEC 25010:2011 validation it became clear that entire organization must be aware of implications and methods re-evaluation to accomplish this certification and its possible impact on organization brand: software and projects with certificated quality.

Before this analysis, all project resources were defined and visualized on elementary Microsoft Excel spreadsheets (Illustration 18) and communication between team leaders, stakeholders and customers were made by email (Illustration 19).

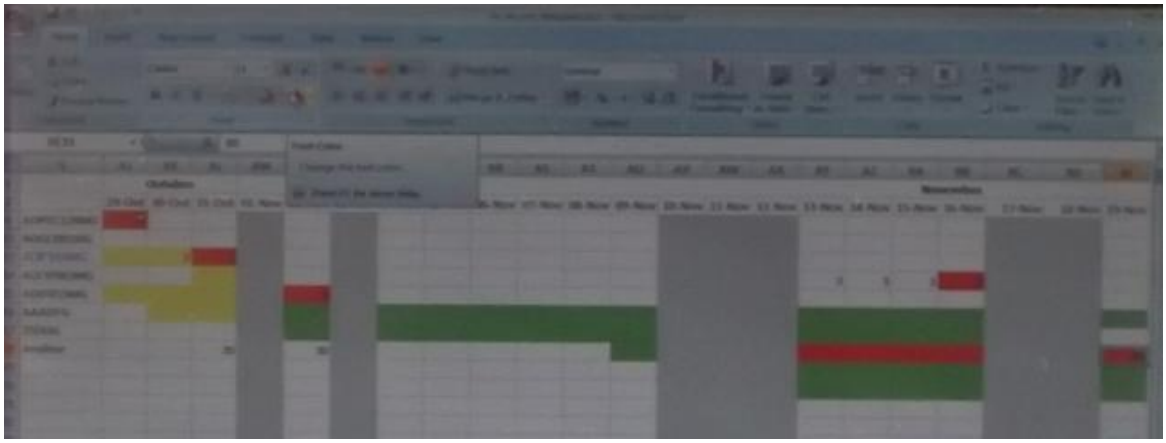

Illustration 18 – Microsoft Excel Projects' Screenshot

Source: Oneself, 2012

It should be emphasized that these screenshots are not legible due to organization confidentiality issues. Project requirements, scheduling, data exchange and associated resources cannot be exposed and shared with third parties.

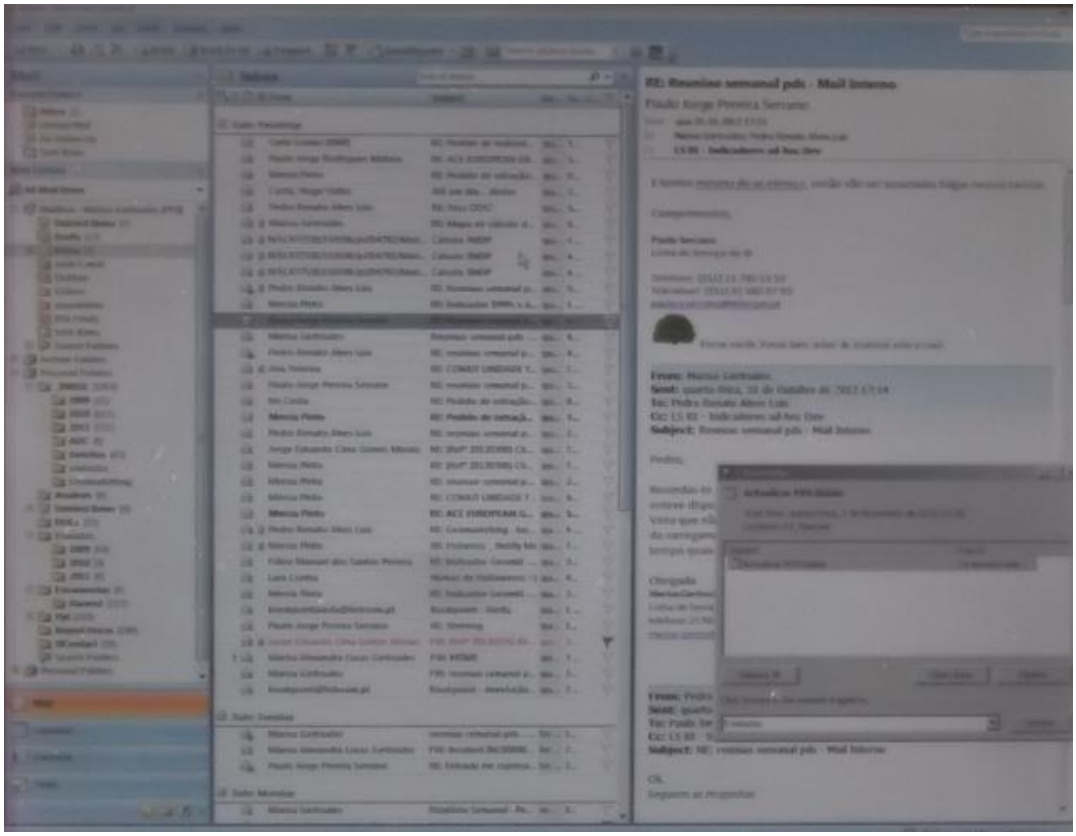

Illustration 19 – Screenshot of Communication Between Stakeholders

Source: Oneself, 2012

With the aim of supporting computer system and target software product, this particular IT Department established two document management platforms (Microsoft SharePoint (Illustration 20 e 21) and Microsoft Project – using team knowledge about Microsoft tools) to process each developed project, stakeholders, files, meetings and deadlines (logging in to projects is managed by team leaders; only those who work in a specific project have access to information about its development). Further, Microsoft SharePoint manages a wide range of data and permissions.

The team leader and consequently, the SharePoint Site leader, needs to perform constant checks on permissions, updates and deadlines to ensure that the confidentiality of each project is maintained. This Microsoft tool allows the team manager to create new forms, documents, links to test software, websites and work areas.

Illustration 20 – Microsoft SharePoint Screenshot

Source: Oneself, 2012

The diagrams from Microsoft Project 2010 (Appendix 3) will help to visualize and meet deadlines according to rules previously adopted. Microsoft (2012) says that Project 2010 *"visually select the right mix of resources – it's as easy as grab and drop with the new team planner. Enhance team collaboration to realize results – connect your teams with Microsoft SharePoint"*.

Website management will be carried out by the team manager who will ensure that benefits are assigned according to projects' specifications, requirements and aggregate resources.

Illustration 21 – Microsoft SharePoint: Users and Permissions' Screenshot

Source: Oneself, 2012

The benefits of the above mentioned Microsoft tools are as follows:

- Decrease the number of archives and projects portfolio (less paper, less amount of items). If necessary, DVDs copies can be used as backup for future reference;
- Remote communication between stakeholders without spending an excessive amount of time in physical meetings (resources and project information to be developed must be present on Microsoft SharePoint and references to deadlines are updated through Microsoft Project); and

- Both platforms are associated with PDCA cycle for software development. Improvements on each evaluation must be implemented on software and shared between Microsoft SharePoint and Microsoft Project (PDCA cycle is reflected on 5S/6S technique).

Regarding the use of the above mentioned Microsoft tools, it was firstly discussed with the team about responsibilities delegation and how to establish the patterns for Microsoft SharePoint users, their role and communication via Microsoft Project (Illustration 22), updates (resources, schedule, responsibilities) and the data exchange at real time. It is important to keep both tools at the same information level so that procedures are followed in the right direction, without compromising projects delivery.

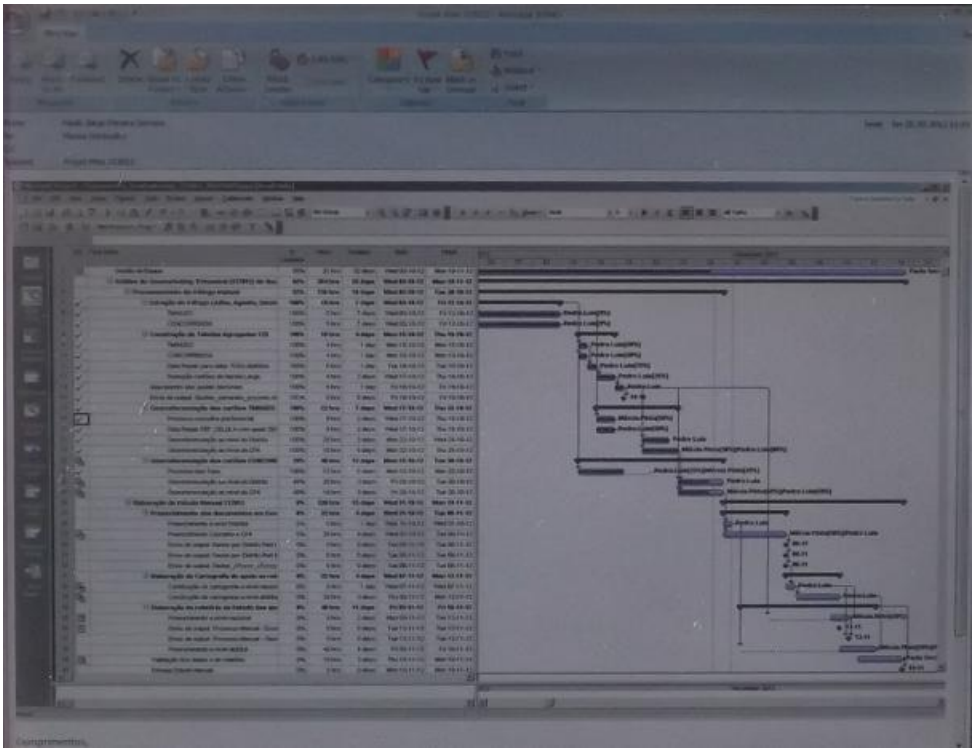

Illustration 22 – Microsoft Project Screenshot

Source: Oneself, 2012

Secondly, after having established concepts and rules to software development and other projects, each Microsoft tool was adapted according to workers' needs to fulfil deadlines and reporting.

Microsoft Project was integrated with Gantt charts on PDCA cycle and resources aggregated to each step of the process flow. For instance, for the step "Plan" the outlined responsibility is to analyse documentation, verify process flow, and define meetings and necessary equipment to start work on projects.

With the development of the case study it necessary to understand the evaluation differences between 5S Work Area Form: Level Two *versus* Level Three (Illustration 23).

Five S Work Area Form

Level Three: "Make It Visual"

Standards/Steps	Owner	Date
Sorting Level 3:	Researcher	
Initial cleaning has been performed and sources of spills and messes are identified and corrected.		
Clean equipment, work area and supply area	Outsourcing	September/October 2012
Identify and correct sources of spills. Leaks, and messes	√	September/October 2012
Simplifying Level 3 (Set in Order):		
Needed items are outlined, dedicated locations are properly labeled, and required quantities are determined.		
Outline locations of equipment, supplies, common areas, safety zones	√	September/October 2012
Develop and build shadow boards	?	September/October 2012
Label needed items and designations locations	?	September/October 2012
Determine required quantities	√	September/October 2012
Document workplace layout, equipment, and supplies	√	September/October 2012
Systematic Cleaning Level 3 (Shine):		
Visual controls and indicators are established and marked for the work area equipment, files, and supplies.		
Identify indicator and control for each work area item to be checked	√	September/October 2012
Mark acceptable performance range for each indicator	?	September/October 2012
Mark direction on indicators and controls	?	September/October 2012
Color-code corresponding indicators and controls	√	September/October 2012
Standardizing Level 3:		
Work group has documented agreements on visual controls, labeling of items, and required quantities of needed items.		
Review documented agreements on visual controls, labeling items and required quantities of needed items with other work groups	√	October 2012
Update these agreements and post	?	October 2012
Sustaining Level 3:		
Work group is routinely checking area to maintain 5S agreements		
Schedule, perform routine checks on equipment, processes and standard methods	?	October 2012
Record problems/opportunities identified during routine checks and daily work activities	√	October 2012
Prioritize problems to resolve: update agreements and post	√	October 2012
Promote 5S accomplishments with photos, group interaction, and celebration	√	October 2012

Illustration 23 – 5S Work Area Form: Level Three

Source: Oneself, 2012 adapted from Leading Edge Group, 2012

This evaluation level began at the end of September 2012 and was implemented in 5 weeks:

- First phase: integration tests of new Microsoft tools (SharePoint and Project); remote access, data exchange and communication tests between IT Department manager, stakeholders and customer.
- Second phase: customers collaboration on platform tests, errors and bugs detection.
- Third phase: production of standard documentation to developed and future projects in accordance with ISO/IEC 25010:2011software model quality.

Sort, Set in Order and Shine were not the priority at this level. Previous levels had a greater focus on physical waste elimination and part of the work was done on an outsourcing basis (Illustration 23).

Waste was also on unnecessary items of a project: software used on other ended project; all kind of documentation on employee's desktops and some rework because not all of them were aware of certain projects' development.

At this stage of the evaluation it was critical to start standardizing some documents, procedures and resources distribution in Microsoft SharePoint and Microsoft Project.

Documentation and visual controls are associated with diagrams in Microsoft Project and with Microsoft SharePoint reporting.

The next team meeting was to clarify questions, unsolved issues and understand employees' motivation. It was also time to carry out another employee evaluation regarding to their expectations, facility to work with Microsoft tools and communication between them and other stakeholders.

Scheduling, graphic reports and updated information are fundamental to understanding of whether a project is being well implemented and within the budget. Errors, problems and opportunities must be examined and then improved through PDCA cycle. It is necessary to prioritize problems that need solving.

The final 6S Evaluation (Illustration 24) brought significant differences to the process flow: unnecessary items do not have place in this philosophy although some items need to be stored for use by sporadic projects.

Score shows that 50% of visual problems, bugs and errors were removed from the process flow: work areas and equipment location are colour-coded or follow a certain

pattern; locations are obvious and easy to identify according to each project; security procedures and equipment are visible and functional.

6S Area: IT Department		Item Score	
		Before	After
Sort (Organization)	**Distinguish between what is needed & not needed**		
	Have all unnecessary items been removed?	2	1
	Are walkways, work areas, locations clearly identified?	1	0
	Does a procedure exist for removing unneeded items?	1	1
Stabilize (Orderliness)	**A place for everything and everything in its place**		
	Is there a place for everything?	2	1
	Is everything in its place?	1	0
	Are locations obvious and easy to identify?	1	1
Shine (Cleanliness)	**Cleaning and looking for ways to keep it clean**		
	Are work areas, equipment, tools, desks clean and free of debris, etc.?	2	1
	Are cleaning materials available and accessible?	1	0
	Are all aisle markings, location indicators, etc., clean & unbroken?	1	1
	Cleaning schedules exist and are posted?	1	0
Standardize (Adherence)	**Maintain & Monitor for adherence**		
	Is all necessary information visible?	1	0
	Are all standards known and visible?	1	1
	Are all visual displays current and up to date?	1	1
	Is there adherence to existing standards?	0	0
Sustain (Self-Discipline)	**Following the rules to sustain**		
	Are procedures being followed?	1	0
	Does an on-going audit and feedback system exist?	0	0
	Does a system exist to respond to audit feedback?	0	0
Safety (Zero incidents)	**Maintaining a safe work place**		
	Is a green tag system in place?	1	1
	Are appropriate controls in place to identify safety equipment?	0	0
	Is all safety equipment unobstructed and accessible?	0	0
	Total Score	18	9
Evaluators Name: Researcher	Scoring: 0= No problems 1= One to Two problems 2= More than Two problems		

Illustration 24 – 6S Evaluation: Final Phase

Source: Oneself, 2012 adapted from Roll, D., 2005

However, due to 5S Work Area Form evaluation being carried out only up to level three, some patterns were not totally accomplished:

- Standard documentation to all procedures including Microsoft tools (reporting, graphics and resources);
- Visual displays were established on employees' desktop and cabinet (where now unnecessary items or items that are not usually necessary to the process flow are stored) but a full Tag System (*"a method for ensuring a safe workplace. The system prescribes that each piece of equipment is inspected for compliance with safety standards with regard to its construction and current condition"*, Roll (2005)) is yet to be adopted by this IT Department.

Krueger (2004) talks about Red Tag System as part of the Sort step (moving items to holding areas). Red Tag process has a specific label for each item (Illustration 25) and it targets inventories, equipment, furniture, storage, clutter, and so on.

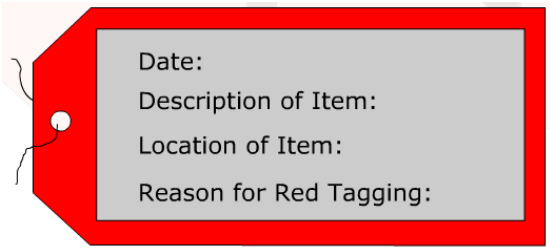

Illustration 25 – Red Tag System

Source: Krueger, K., 2004, p.5

The final evaluation (up to level three) has shown significant changes on the IT Department workplace and particularly, benefits the nonphysical aspect from a technological environment: the organization of software and developed projects through new work tools. Using 5S/6S represents a small percentage of Lean tools but as an experimental thematic on this particular context (taking into account organization dimension) it revealed that it is possible to reorganize technology and work with less waste and more added value.

6. Conclusions and Future Work Perspectives

This chapter summarizes the work carried out to complete the master degree in Organizational Information Systems.

Chapter 6.1. resumes the importance of Lean/ Lean IT to an organization and provides answers to the research question *"How could 5S/6S add value to an organization?"* and Chapter 6.2. analyses the impact of 5S/6S Technique in one specific IT Department and what would be the future work perspectives for other departments or even the entire organization.

6.1. Conclusions

The fundamental Lean measurement is the cycle time; it is what feeds the system level indicator and its processing capacity. It is through cycle time that the waste can be discovered. Cycle time is influenced by the implementation process, therefore, each failure or bad implementation will increase the cycle time. It should also be noted that the definition of waste can vary, depending on problem to be solved and on the understanding of who is trying to solve the problem.

In this project, a standard approach was used to interpret the problem, this involved defining the problem, analysing the situation, creating hypotheses, running tests or releasing prototypes, verifying results and monitoring. This approach was found to be a good way of optimizing the entire organization whilst respecting people, increasing knowledge and integrating quality in internal processes. Further, it was found that services and software should be made quickly; taking into consideration the developed standards; and that commitment and process waste elimination contributed to the clarification and pursuit of the improvement plan.

It has also be seen that a reliable and repeatable cycle time should be established for each project and then reduced through continuous improvement, for this purpose it has been found that human resources play a crucial part in the time reduction and increased value. For such cooperation the organization should perpetuate quality services and reformulate patterns whenever it benefits the whole department/organization.

Time reduction is important as it is reflected on meeting deadlines, quantity of productive work, delivery speed and proper resources use.

This project concludes that Lean development meets the cycle time analysis and customer satisfaction and that the true challenge resides in solving internal problems on a process flow such as delays, waste, and so on; and in the optimization of the necessary resources to accomplish goals. Focus should rely on the processes efficiency, capacity to respond quickly to any demand, customer value and knowledge.

Another concern for any organization is the financial return that comes from each project (ROI) through monitoring outcomes. Development teams should be aware of the financial implications and work towards decision making that respects associated costs/benefits.

With this project, it was possible to approach Lean to IT environment, being this just the initial step (nonetheless, bearing in mind that the general Lean evaluation and techniques are already widely respected and well implemented in different sectors). Even though concepts can vary, they can still be adjusted to analyse the environment and fix possible problems. Lean principles and types of waste are integrated in IT perspectives providing the relevant tools to the understanding of the process flow and improved results.

Indeed, Lean IT may be complementary to Information Technology Infrastructure Library (ITIL) ("ITIL is the most widely accepted approach to IT service management in the world. ITIL provides a cohesive set of best practice…" by APM Group Ltd (2012)), Green IT ("Green IT refers to the study and practice of using computers and IT resources in a more efficient and environmentally responsible way." by McCabe (2009)) and ISO/IEC 20000 standards ("ISO/IEC 20000…allows companies to demonstrate excellence and prove best practice in IT management." by APGM International (2012)).

When applying 5S/6S technique in an IT environment it was possible to understand how the workspace area could be organized and visualized so that the time consuming waste decreases and other problems could be solved within the process flow.

After the initial studies about Lean technique, principles, types of waste, IT and the implementation in a particular IT Department, the results responded positively to the

research question *"How could 5S/6S add value to an organization?"*. It was observed that this addition of value could be achieved through the organization of the process flow, resources, physical workspace area, communication with other departments and focus on each step of the developed software or service.

There are various other techniques recommended to be applied in IT environments, however, for his case study the focus was on the application of the 5S/6S technique as it served as an example of Lean technique application. Nonetheless, it would still be interesting to apply other techniques and compare them (for instance, *Kanban*, *Kaizen* and so on).

5S/6S technique focus is on the work process. Is useful to organize archival records (physical or nonphysical), decrease cycle time (gaining time on deadlines), and involve employees on their work environment. As a Lean methodology 5S/6S helps to produce products (in this case, software or developed projects) that add value to customers.

6.2. Future Work Perspectives

The IT Department is not the only one that accumulates waste and cost money to any organization. Like other departments it is necessary to coordinate all the resources according to each project.

5S/6S technique is one of the possible Lean methodologies that could be applied to IT environment. Work space area is adjusted as the main physical space to work on IT projects but it is crucial to pay also attention to technology equipment and software management. After applying 5S/6S technique on development environment (up to level Three evaluation) significant improvements were detected:

- Rapid and effective utilization of files required for a project evaluation;
- Re-distribution of work according to specific skills of each human resource/project skills;
- Mechanics for internal IT Department communication and other stakeholders (for example, daily meetings with 15 minutes to discuss what was previously done and what is missing to accomplish deadlines);

- Constant communication between the Project Manager and customers, reporting mini tests or prototypes of the project and receiving feedback (through Microsoft SharePoint and Microsoft Project tools);
- Metrics such as number of projects delivered in time, accomplish of personal team motivation to each project, registration of errors, bugs, delays, and so on.

All these improvements must be measured and analysed preferentially with statistical software. To understand what is written and what should be the evaluation, the chief department and top management are crucial to the process. The final improvement decisions are made by them.

But it is necessary to understand that this evaluation must continue up to Level Five in order to emerge a method to share and implement improvement ideas across other areas and determine common methods and standards. When all the possible improvements are implemented, tested and documented, it is time to raise the level and try new IT, Innovation and Management Certificates which fall into IT environment and development. It will collaborate to enhance marketing, brand, sales and customer trust. Metrics and benefits can be replicated to other departments and that is how Lean philosophy will spread to the entire organization.

5S/6S technique will also help to write standard documents and evidence to accomplish ISO/IEC 25010:2011 certification. Hereafter, to achieve this certification it is necessary to accomplished all evaluation levels.

All processes should be supported on PDCA cycle (described on this dissertation on Chapter 2.2 about dimensions of Lean IT studied by Bell & Orzen (2010)).

It works as a concept that helps to plan, act and revise concepts. The search is for continuous improvement on the process flow, following the sequence below:

- Plan: identity work team, problems, waste, deadlines; analyse definitions, causes and start to work on resolutions (plan must contemplate customers and other stakeholders involved on the process);
- Do: communicate with team, understand team responsibilities, design diagrams with responsibilities, deadlines and sprints (amount of work to each step); develop an resolution plan (according to each project or software development) and execute it;
- Check: control and monitor all process flow steps, for instance, document management, remote communication and necessary items;

- Act: analyse results; rework on defects; improve standards (if possible).

According to Orticio (2010), *"...combined with PDCA cycle, also called the Deming Cycle, 5S/6S ensures continuous quality improvement starting from the top of the corporate ladder"*. PDCA is a continual cycle, meaning that it is always important to return to "Plan" step and start to think again about improvements on specific projects.

When all departments are covered by this paradigm, we can call the entire organization as a Lean environment, with standard procedures, less waste, achieved KPIs, always seeking for improvements, motivated employees and satisfied customers.

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*n.a. means **not available**

Appendix

Appendix 1: 6S Evaluation by Don Roll

6S Area: [Name the work area]		Item Score	
		Before	After
Sort (Organization)	**Distinguish between what is needed & not needed**		
	Have all unnecessary items been removed?		
	Are walkways, work areas, locations clearly identified?		
	Does a procedure exist for removing unneeded items?		
Stabilize (Orderliness)	**A place for everything and everything in its place**		
	Is there a place for everything?		
	Is everything in its place?		
	Are locations obvious and easy to identify?		
Shine (Cleanliness)	**Cleaning and looking for ways to keep it clean**		
	Are work areas, equipment, tools, desks clean and free of debris, etc.?		
	Are cleaning materials available and accessible?		
	Are all aisle markings, location indicators, etc., clean & unbroken?		
	Cleaning schedules exist and are posted?		
Standardize (Adherence)	**Maintain & Monitor for adherence**		
	Is all necessary information visible?		
	Are all standards known and visible?		
	Are all visual displays current and up to date?		
	Is there adherence to existing standards?		
Sustain (Self-Discipline)	**Following the rules to sustain**		
	Are procedures being followed?		
	Does an on-going audit and feedback system exist?		
	Does a system exist to respond to audit feedback?		
Safety (Zero incidents)	**Maintaining a safe work place**		
	Is a green tag system in place?		
	Are appropriate controls in place to identify safety equipment?		
	Is all safety equipment unobstructed and accessible?		
	Total Score		
Evaluators Name:	Scoring: 0= No problems 1= One to Two problems 2= More than Two problems		

Appendix 2: Five S Work Area Form by Leading Edge Group

Appendix A: Level One

Five S Work Area Form

Level One: "Just Beginning"

Standards/Steps **Owner** **Date**

Sorting Level 1:

Needed and not-needed items are mixed throughout the work area.

- ☆ Obtain a layout for work area and mark 5 S boundaries _____
- ☆ Obtain a (digital preferred) camera and take baseline photos _____
- ☆ Assign work group members to their 5 S areas _____
- ☆ Identify a place to put not-needed items _____
- ☆ Obtain cleaning supplies _____

Simplifying Level 1:

Items are placed randomly throughout the workplace.

- ☆ Clarify boundaries of individual work stations and common areas _____
- ☆ Clarify who is responsible for different work are locations and common areas _____
- ☆ Obtain existing standards for color-coding _____
- ☆ Obtain markers, tape and foam for outlining and color-coding _____
- ☆ Obtain wood, foam, and other supplies for shadow boards _____

Systematic Cleaning Level 1:

Key work area items to be checked and not identified and are unmarked.

- ☆ Determine communication and decision making for work areas involving multiple shifts _____
- ☆ Determine other groups to coordinate and communicate with while determining key items to be checked for the work area _____
- ☆ Determine location of equipment manuals and procedures _____

Standardizing Level 1:

Work are methods are not consistent followed and are undocumented.

- ☆ Gather lists and diagrams of daily cleaning responsibilities _____
- ☆ Identify workplace methods currently used _____

Sustaining Level 1:

Work area checks are randomly performed and there is no visual measurement of 5 S performance.

- ☆ Designate location fro tracking 5 S performance _____
- ☆ Evaluate initial 5 S Level of Achievement _____
- ☆ Install 5 S Communication Board and assign responsibility for updates _____
- ☆ Determine 5 S targets, activities and schedule _____
- ☆ Review 5 S plans with entire work group and site leadership _____

Appendix B: Level Two

Five S Work Area Form

Level Two: "Focus on Basics"

Standards/Steps **Owner** **Date**

Sorting Level 2:

Needed and not-needed items are identified and those not-needed are removed.

- ☆ Establish criteria for needed and not-needed
- ☆ Identify the needed from the not-needed and move not-needed items to designated holding area
- ☆ Conduct a white elephant sale
- ☆ Remove excess equipment, supplies, computer files, software and other items not-needed: dispose of unsafe items

Simplifying Level 2:

Needed items are safely stored and organized according to frequency of use.

- ☆ Group items and supplies according to use
- ☆ Determine a location for each item based on frequency of use

Systematic Cleaning Level 2:

Key work area items to be checked are identified and acceptable performance levels documented.

- ☆ Identify key items to check to ensure proper equipment and process performance
- ☆ Determine acceptable performance ranges for key equipment and processes

Standardizing Level 2:

Work group has documented agreements for needed items, organization, and work area controls.

- ☆ Review 5 S documented agreements for needed items, workplace layout, daily checks and acceptable performance with other work areas that will be affected
- ☆ Update these agreements and post

Sustaining Level 2:

Initial 5 S has been determined, and performance is documented and posted in the work area.

- ☆ Take work area photos to show improvement
- ☆ Evaluate current 5 S Level of Achievement
- ☆ Document the current 5 S level using the 5 S Progress Form and post in designated area

Appendix C: Level Three

Five S Work Area Form

Level Three: "Make It Visual"

Standards/Steps **Owner** **Date**

Sorting Level 3:

Initial cleaning has been performed and sources of spills and messes are identified and corrected.

- ☆ Clean equipment, work area and supply area
- ☆ Identify and correct sources of spills. Leaks, and messes

Simplifying Level 3:

Needed items are outlined, dedicated locations are properly labeled, and required quantities are determined.

- ☆ Outline locations of equipment, supplies, common areas, safety zones
- ☆ Develop and build shadow boards
- ☆ Label needed items and designations locations
- ☆ Determine required quantities
- ☆ Document workplace layout, equipment, and supplies

Systematic Cleaning Level 3:

Visual controls and indicators are established and marked for the work area equipment, files, and supplies.

- ☆ Identify indicator and control for each work area item to be checked
- ☆ Mark acceptable performance range for each indicator
- ☆ Mark direction on indicators and controls
- ☆ Color-code corresponding indicators and controls

Standardizing Level 3:

Work group has documented agreements on visual controls, labeling of items, and required quantities of needed items.

- ☆ Review documented agreements on visual controls, labeling items and required quantities of needed items with other work groups
- ☆ Update these agreements and post

Sustaining Level 3:

Work group is routinely checking area to maintain 5 S agreements

- ☆ Schedule, perform routine checks on equipment, processes and standard methods
- ☆ Record problems/opportunities identified during routine checks and daily work activities
- ☆ Prioritize problems to resolve: update agreements and post
- ☆ Promote 5 S accomplishments with photos, group interaction, and celebration

Appendix D: Level Four

Five S Work Area Form

Level Four: "Focus on Reliability"

Standards/Steps **Owner** **Date**

Sorting Level 4:

Work area has agreements on housekeeping responsibilities and schedules, and assignments are consistently followed.

- ☆ Reduce the amount of equipment and supplies needed
- ☆ Determine ongoing housekeeping responsibilities, cleaning frequency and who will perform the tasks

Simplifying Level 4:

Needed items in work area have been minimized in number and are properly arranged for retrieval and use.

- ☆ Store needed items in a manner to maintain ready-for-use status
- ☆ Identify ways to ensure equipment, files, supplies are ready for use
- ☆ Arrange needed items in the order of use so only one hand or motion is required for retrieval
- ☆ Arrange needed items so they can be returned with one hand, one motion, or one step

Systematic Cleaning Level 4:

Inspection occurs during daily cleaning or work areas and equipment and supplies are restocked.

- ☆ Clean key equipment and supplies locations daily
- ☆ Establish clear standards of performance for key items checked and inspect them daily
- ☆ Identify countermeasures to take for abnormal conditions

Standardizing Level 4:

Reliable methods and standards for housekeeping, daily inspections, and workplace arrangement are documented and followed by work group.

- ☆ Review the new methods and standards with all employees and make changes to support the use of the new methods
- ☆ Train all employees in how to perform the new methods
- ☆ Update agreements

Sustaining Level 4:

Sources and frequency of problems are documented as part of routine work, root causes are identified and corrective action plans developed.

- ☆ Determine frequency and timing of routine checks and 5 S audits
- ☆ Continue regular review of recorded problems/opportunities
- ☆ Resolve problems at their root to eliminate causes of backsliding

Appendix E: Level Five

Five S Work Area Form

Level Five: "Continuously Improve"

Standards/Steps **Owner** **Date**

Sorting Level 5:

Cleanliness problem areas are identified and mess prevention actions are in place.

- ☆ Identify sources of cleanliness problems
- ☆ Identify methods to eliminate or reduce cleanliness problems
- ☆ Identify methods to reduce frequency or time required in maintaining work area cleanliness
- ☆ Establish common cleaning methods and standards across like areas
- ☆ Modify equipment and product design to reduce/eliminate tools needed

Simplifying Level 5:

Needed items can be retrieved within 30 seconds and require minimum number of steps.

- ☆ Develop visual displays to communicate status of critical information at a glance
- ☆ Use common arrangement and labeling across work areas

Systematic Cleaning Level 5:

Potential problems are identified and countermeasures are documneted.

- ☆ Identify how to predict problems before actual occurrence
- ☆ Identify actions to take to prevent problems from occurring
- ☆ Establish common Systematic Cleaning procedures across all areas

Standardizing Level 5:

Reliable methods and standards for housekeeping, daily inspections, and workplace arrangement are shared and are used throughout similar work areas.

- ☆ Identify similar work areas and determine common methods and standards to follow

Sustaining Level 5:

Root causes are eliminated and improvement actions focus on developing preventive methods.

- ☆ Develop a method to share and implement improvement ideas across similar work areas
- ☆ Plan a celebration!

Appendix 3: Demo Microsoft Project 2010 by Addintools